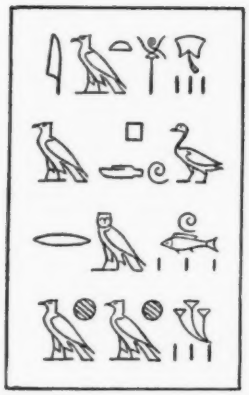
THE JOURNAL OF WILDLIFE MANAGEMENT



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THE JOURNAL OF WILDLIFE MANAGEMENT

VOLUME 23 OCTOBER 1959 NUMBER 4

REPRODUCTION AND PRODUCTIVITY OF NEWFOUNDLAND MOOSE

Douglas H. Pimlott[1]

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The object of this paper is to report on the reproduction and productivity of Newfoundland moose (*Alces alces*).

The field work described here was carried out as part of a moose-research program designed to provide a factual background on which moose hunting could be managed in the province. Because the published literature (Murie, 1934; Hosley, 1949) has suggested that North American moose have a low reproductive potential, the present paper seeks to test this hypothesis by (1) reporting data on pregnancy rates, frequencies of twinning rates, and calf-cow ratios obtained in Newfoundland from 1950 to 1956; and (2) presenting rates of net productivity that represent allowable rates of exploitation.

ACKNOWLEDGMENTS

The study was characterized by the cooperation of many people and organizations, including hunters, moose-record-card cooperators, staff members of the Anglo-Newfoundland Development Company, field staff of the Department of Mines and Resources, newspapers, and local radio news bulletins, particularly the Gerald S. Doyle Bulletin. Although restriction on space limits their mention here by name, I gratefully acknowledge the help of all these contributors, especially Wildlife Officers Arthur Butt, S. J. Hall, George Hicks, Jr., Ephraim Balsom, and R. J. Callahan of the Department of Mines and Resources and Earl Penny of the Anglo-Newfoundland Development Company. My wife, Dorothy, compiled the moose-record-card returns, much of the reproductive-tract data, and assisted me in the Sandy River Study Area. George Speidel of the Washington Park Zoological Gardens in Milwaukee, Wisconsin, provided me with the reproduction records of a captive moose herd. The study was conducted while I was employed by the Newfoundland Department of Mines and Resources. Program planning and preparation of this report were carried out at the University of Wisconsin under the direction of J. J. Hickey and R. A. McCabe; H. W. Mossman supervised my work on the ovarian material. I am indebted to B. S. Wright for his considerable assistance in initiating this study and to R. Y. Edwards, R. A. Rausch and R. O. Skoog for critical advice in its later stages. I am also grateful for the financial support of the Wildlife Management Institute during a year and a half when I was doing laboratory work and preparing this report.

BACKGROUND INFORMATION

In 1950, moose-record cards, which were first used for the gathering of population data by Hatter (1950) in British Columbia, were distributed to the field staff of the Department of Mines and Resources and to volunteer co-operators (Pimlott, 1953). These cards were used for a 6-year period, 1950 through 1955. In all, 9,881 observations of moose were reported, of which 8,610 were identified by sex and age. In 1952, two field parties worked from June to September, and a third party from June through October, with the principal objective of classifying moose for sex and age (Pimlott, *ibid.*). Field parties continued classifying animals observed in the field up to 1956, although no further studies were undertaken

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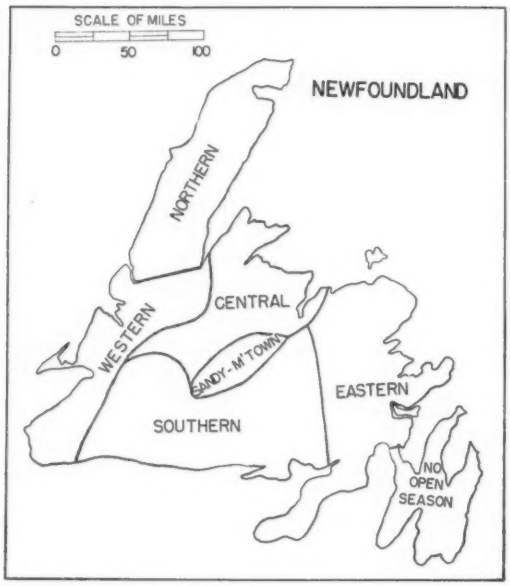

FIG. 1. Districts in which collections of mandibles and reproductive tracts were made. The Sandy-Millertown area in the Central District was the subject of an intensive study.

with this as the principal objective. In a total of 6,168 observations, 4,985 moose were identified by sex and age.

In the 4 years from 1953 to 1956, mandibles from both bulls and cows, and the reproductive tracts from cows, were obtained from hunters. The 1953 and 1956 collections were island-wide; the 1954 and 1955 collections were from central Newfoundland. A total of 2,017 mandibles and 516 usable reproductive tracts were collected. An additional 52 reproductive tracts were collected during the winters of 1951–52 and 1952–53. These tracts were obtained from animals collected for study, animals accidentally or illegally killed, and animals that died during a moose-trapping program (Pimlott and Carberry, 1958).

The reproduction data were not collected uniformly over the entire island. Most of the observational data and the reproductive tracts were collected in three districts—western, central, and eastern (Fig. 1)—in an area of approximately 20,000 square miles.

Early in the study, I recognized that high moose density existed in a 1,500-square-mile section of the Central District (Fig. 1) that lies south of the Exploits River between Red Indian Lake and Sandy River. The section, uninhabited except for the staffs of two pulpwood-cutting operational districts, can be entered at only two points. Due to its limited accessibility and to the high moose density there, the area has had, since 1954, a 2- to 4-month hunting season (between September and December), as compared to a 1-month season (December) in more accessible areas. The limited access simplified our work of contacting hunters and picking up material from their kills. Approximately half of the total collection of reproductive tracts came from this area, referred to henceforth in this paper as the "Sandy-Millertown area."

In 1953, when we began the large-scale program of collecting reproductive tracts and mandibles, every license sold was accompanied by a circular letter. Many of the local radio news bulletins carried announcements and news releases, and every newspaper on the island carried a story about our work. In addition to giving the reasons for, and objectives of, the program, we announced that all hunters who co-operated would receive a 5- by 7-inch photograph of a moose or caribou (*Rangifer caribou*). Most of the newspapers illustrated their stories with one of these photographs. In 4 years we distributed over 2,000 photographs at a cost of approximately $400. I believe that the photographs played an important part in stimulating hunter interest and also in aiding the fieldmen to make hunter contacts. In 1953, we received mandibles and/or uteri from approximately 25 per cent of all animals that were killed. This is in marked contrast to the experience of Edwards and Ritcey (1958), who received very little co-operation from British Columbia hunters and who had to rely almost entirely on guides to obtain moose reproductive tracts and mandibles.

In 1953, the first year of the program, the circular letter included very terse instructions about how to locate and handle the reproductive tract. Later we used simple diagrammatic sketches of a uterus and man-

dible to illustrate more exactly what was wanted. The completeness and the condition of the material received varied greatly. In 225 cases the complete reproductive tract and the mandible were received; in others, one or both ovaries were missing or the fetuses had been removed.

Sandy River, in the Sandy-Millertown area, was the site of our principal study area in the fall of 1952, summer and fall of 1953, spring, summer, and fall of 1954, and in the spring, summer, and fall of 1956. Duplication among 4,802 observations of moose there was undoubtedly quite common. Since we made no attempt to separate individual moose from one observational period to the next, no confidence limits can be placed on population statistics derived from these data.

The study-area observations were made by a number of people who worked at various times on the moose-research program. I spent approximately 6 months in the area and made approximately one-half of the observations. Donald G. Dodds (1955, 1958) also worked in the area in 1953 when he investigated various aspects of moose ecology. His observations are included in the data discussed here.

Aging of yearling and older animals was done by the tooth-erosion method (Passmore, Peterson and Cringan, 1955). The results of a recent study (Sergeant and Pimlott, 1959) cause me to believe that this method tends to underestimate age and to give erratic results in the older age classes. As the percentage of error in aging class IV and older animals by this method appears to be quite high, I have grouped the data for the older classes as class IV+ in the present paper.

In the discussions that follow I will use the term "significant" to indicate a probability level of at least 5 per cent and "highly significant" to indicate a 1 per cent level.

INITIAL BREEDING AGE

The initial breeding age of moose has been one of the unknowns of moose ecology. The early semipopular works (Stone, 1902; Merrill, 1918; Seton, 1929) and the more recent technical studies (Murie, *op. cit.*; Hosley, *op. cit.*; Peterson, 1955) either have not mentioned the topic or have not presented conclusive data on it. In discussing the point, Peterson (*ibid.*:99) stated, "Rough indications found in this study seem to sub-

TABLE 1.—PREGNANCY RATES FOR NEWFOUNDLAND MOOSE, 1951–56

PERIOD AND DISTRICT	YEARLINGS (Sample Size)	YEARLINGS Per Cent Pregnant	AGE UNKNOWN[1] (Sample Size)	AGE UNKNOWN[1] Per Cent Pregnant	ADULTS (Sample Size)	ADULTS Per Cent Pregnant	TOTAL SAMPLE (Sample Size)	TOTAL SAMPLE Per Cent Pregnant	0.05 C.L.
DEC. TO MAY									
Central									
Sandy-M'town	(34)	29	(33)	61	(116)	74	(183)	63	57–69
Remainder	(11)	64	(8)	75	(16)	94	(35)	80	61–92
Entire district	(45)	38	(41)	63	(132)	77	(218)	66	60–72
Western	(15)	47	(19)	68	(62)	84	(96)	75	65–83
Eastern	(18)	67	(29)	90	(38)	87	(85)	82	73–91
Southern	—	—	(8)	87	(7)	100	(15)	93	78–100
W-E-S total	(33)	58	(56)	82	(107)	86	(196)	80	74–86
Entire Island	(78)	46	(97)	74	(239)	81	(414)	73	69–77
NOVEMBER									
Sandy-M'town	(28)	17	(25)	48	(50)	48	(102)	40	30–50
Other areas	(1)	0	(1)	0	—	—	(6)	50	—
Entire island	(29)	14	(26)	46	(50)	53	(108)	41	31–51
NOV. TO MAY									
Entire island	(107)	37	(123)	68	(289)	75	(519)	66	62–70

[1] Unknown-age class contains only yearling and adult animals.

TABLE 2.—*In utero* PREGNANCY AND TWINNING RATES FOR NEWFOUNDLAND MOOSE BY AGE CLASSES, 1951–56

AGE CLASS[2]	PREGNANCY RATES			TWINNING RATES[1]		
	(Sample Size)	Per Cent Pregnant	0.05 C.L.	(Sample Size)	Per Cent Twins	0.05 C.L.
I	(107)	37	28–47	(32)	3	0–27
II	(74)	72	62–82	(45)	11	4–24
III	(87)	78	71–85	(57)	16	7–29
IV+	(128)	74	66–82	(80)	15	7–23
Age?[3]	(123)	69	61–77	(69)	11	7–19
All ages	(519)	65	61–69	(283)	12	9–15
Adults	(289)	75	70–80	(182)	14	9–19

[1] The number of animals in the twinning-rate sample is always less than the number of animals pregnant. This is the result of fetuses having been removed from the uteri by hunters.

[2] Age classes after Passmore, Peterson, and Cringan (1955).

[3] Unknown-age class contains only yearling and adult animals.

stantiate the conclusion reached by several authors that at least a few of the females are successfully bred at the age of 16 months and produce offspring on their second birthday." Peterson, who did not elucidate on the evidence upon which he based his conclusion, also stated that Lönnberg (1923) reported similar findings for Sweden. In a more recent Swedish work, Skuncke (1949: 32) concluded that, although a few yearlings do breed, some cows do not breed for the first time until they are 3½ years old. Skuncke's conclusions appear to be based mainly on field observations and on the breeding records of captive animals. Large-scale collections of postbreeding-season uteri apparently have not been made.

Evidence based on fall and winter reproductive-tract collections from British Columbia (Edwards and Ritcey, *op. cit.*) and Newfoundland indicates that yearling breeding is highly variable. In the known-age segment of the British Columbia data, there were 15 yearlings, none of which was pregnant. On the evidence supplied by these nonpregnant reproductive tracts, and on information obtained from hunters and guides, Edwards and Ritcey concluded that female moose in their study area breed first as 2-year-olds.

Uteri of 107 yearlings were collected in Newfoundland (Tables 1, 2). In this collection, which included November animals, 37 per cent of all yearlings were pregnant. Of the 78 yearlings collected during December or later, 46 per cent were pregnant (Table 1). Within this sample the greatest variation existed between animals collected in the Sandy-Millertown area (29 per cent pregnant in a sample of 34) and in the Eastern District (67 per cent pregnant in a sample of 18 animals). Although these differences are not statistically significant, their magnitude, combined with the generally higher reproductive level, which in later sections of this paper will be shown to exist in the Eastern District, suggests that the higher incidence of pregnant yearlings is not random variation, but a biological fact.

An ovarian study of the nonpregnant animals provided additional information on the number of animals that came into breeding condition as yearlings. Forty-two yearlings collected in December or later showed no uterine evidence of pregnancy. Both ovaries were collected for 25 of the 42 animals, and in 9 such cases the ovaries contained primary corpora lutea. This indicated that in excess of 60 per cent of all female yearlings came into breeding condition. In the case of yearlings from the Eastern District, the incidence was higher; 15 of the 18 animals collected, 83 per cent, were either pregnant or had a corpus luteum in their ovaries.

An additional source of information on the initial breeding age is provided by the breeding records of captive moose, of Ontario stock, in the Milwaukee Zoo. Four female calves have been raised to breeding age. Two of the four bred successfully as

TABLE 3.—NORTH AMERICAN OBSERVED TWIN-CALF PERCENTAGES

Area	Period (Season)	Original Source[1]	Sample Size	Per Cent Twins	0.05 C.L.	Reference
Isle Royale	1929–30 (Spring-fall)	Writer	87	5	2–12	Murie, 1934
Br. Columbia	1946–47 (Fall)	Writer	102	12	6–20	Hatter, 1950
Ontario	1947–49 (Year round)	Rec. cards	415	23	19–28	Peterson, 1955
Quebec	1950 (Year round)	Rec. cards	274	28	22–34	Moisan, 1952
N. Brunswick	1950–56 (Year round)	Rec. cards	385	17	13–21	Wright, 1956
Alaska	1951–53 (Fall-winter)	Writers	1,217	13	11–15	Spencer and Chatelain, 1953
Newfoundland All districts	1950–56 (Year round)	Rec. cards + field parties	1,158	15	13–17	This study
Study area	1952–56 (Spring-fall)	Field parties	422[2]	2	—	This study

[1] The source is listed as "writer" when the data were collected by the person(s) named in the reference. The term "Rec. cards" indicates data collected by co-operators and reported on special cards. "Field parties" were comprised of persons working on moose-research programs.

[2] Duplication of observations was undoubtedly common, hence confidence limits are not calculated.

yearlings and a third as a 2-year-old. The fourth suffered from a vitamin deficiency and did not breed during its life.

I found no evidence of calves breeding in Newfoundland. Thirty-nine calf reproductive tracts were examined. All uteri were very small, and none of the ovaries contained follicles larger than 2 mm. in diameter.

NUMBER OF YOUNG

Early authors (Stone, *op. cit.*; Merrill, *op. cit.*; Seton, *op. cit.*) did not deal quantitatively with the question of young. It was generally stated that moose have one or two young, rarely three.

Occurrence of Twins

In his book on Swedish moose, Skuncke did not give quantitative data on the occurrence of twins in the wild; however, he quoted figures on the occurrence of calves that were obviously based on large samples, for he referred (1949:307) to one sample of between 800 and 900 as being of limited value because of its small size. In a later section (1949:332) he made it clear that twins are the rule, for in his productivity calculations he assumed that during the 14 years of the prime reproductive period, a cow would average 1.79 calves a year. Skuncke's (1949:66, 67) breeding records

TABLE 4.—DISTRICT OCCURRENCE OF TWINS *in utero*, 1951–56

District and Area	Yearlings (Sample Size)	Yearlings Per Cent Twins	Age Unknown[1] (Sample Size)	Age Unknown Per Cent Twins	Adults (Sample Size)	Adults Per Cent Twins	Total Sample (Sample Size)	Total Sample Per Cent Twins	Total Sample 0.05 C.L.
Central									
Sandy-M'town	(14)	0	(26)	4	(87)	3	(127)	3	1–8
Remainder	(4)	0	(8)	12	(12)	17	(24)	12	—
Entire district	(18)	0	(34)	6	(99)	5	(151)	5	2–11
Western	(6)	17	(12)	17	(49)	16	(67)	16	8–28
Eastern	(8)	0	(16)	25	(29)	41	(53)	30	18–44
Southern	—	—	(7)	0	(5)	20	(12)	8	—
W-E-S total	(14)	7	(35)	7	(83)	25	(132)	21	14–30
Entire island	(32)	3	(69)	12	(182)	14	(283)	12	8–17

[1] Unknown-age class contains only yearling and adult animals.

of two captive cows supported his assumption: A total of 19 pregnancies, 11 and 8, resulted in the birth of 36 calves.

There is no record of a North American moose population achieving the high twinning rate which Skuncke believed to be the rule in Sweden. Observed rates have varied from 2 to 28 per cent (Table 3), while *in utero* rates have not exceeded 30 per cent for any area (Table 4). In a previous analysis of cow-with-calf ratios and twinning rates (Pimlott, 1953), I included only observations made in the July–December period, because I believed that data collected during this period would give ratios more closely approximating conditions at birth than data collected the year round. Although there is justification for such a breakdown, I have included observations for the entire year in Table 3. This permits comparisons to be drawn with mainland areas where moose-record cards have also been used. The breakdown of the Newfoundland data by months from May to October, and by quarters from November to April, is given in Table 5.

Area Variation in Twinning Rate

In his compilation, Hosley (*op. cit.*) reviewed a number of unpublished reports of the U.S. Fish and Wildlife Service, as well as the published literature. He was impressed by the variation in the twinning rate in different continental areas and suggested that twinning decreases with poorer range conditions. Peterson (1955:56) also commented on the variations in observed twinning rates between areas but concluded that the data then available did not warrant critical analysis. Hatter (*op. cit.*) stated that, during the period when moose were colonizing new areas in British Columbia, twin calves were very common.

A study of Table 3 suggests that there are undoubtedly many variables present in the occurrence of twins. A number of the variables, however, can be removed by making interarea comparisons of data collected by the same methods and for the same periods of the year; and by making intra-area comparisons where data can be broken down into district groupings.

Moose record-card twinning data for Ontario (Peterson, 1955:57), Quebec (Moisan, 1952), New Brunswick (Wright, 1956) and Newfoundland show some significant differences (Table 3). These exist between Quebec and New Brunswick or Newfoundland, and between Ontario and Newfoundland. The Ontario data were divided by Peterson (1955:57) into four separate areas for the 3-year period. In three of the areas the percentage occurrence of twins ranges from 23 to 27 per cent, and in the fourth it drops to approximately 10 per cent. However, these differences are not significant.

The Alaska data were also divided into four separate areas (Spencer and Chatelain, 1953). The averages for the areas are: Kenai Peninsula, 12 per cent twins in 254 observa-

TABLE 5.—SEASONAL OCCURRENCE OF ADULT COWS AND CALVES OBSERVED, 1951–56[1]

PERIOD	NO. OF COWS SEEN WITH			TOTAL NO. OF COWS	PER CENT OF COWS WITH CALVES	0.05 C.L.	PER CENT OF TWINNING[2]	0.05 C.L.
	No Calves	1 Calf	2 Calves					
May	299	54	6	359	17	12–22	10	4–24
June	297	127	41	465	36	31–41	24	17–32
July	308	160	35	503	39	34–43	18	13–25
August	324	191	37	552	41	36–46	16	11–21
September	321	136	18	475	32	27–37	12	6–19
October	212	113	16	341	38	32–44	12	6–19
Nov.–Jan.	291	151	17	459	37	32–42	10	6–16
Feb.–April	138	49	7	194	29	22–36	12	5–24
Totals and means	2,190	981	177	3,348	35	33–37	15	13–17

[1] Includes all observational data except that from Sandy study area.

[2] This is a percentage of the observed cows that were followed by two calves.

tions; Susitna Valley, 12 per cent twins in 753 observations; Copper River, 17 per cent twins in 116 observations; and Alaska Peninsula, 33 per cent twins in 60 observations. A highly significant difference is present between the data for the Alaska and Kenai peninsulas and between the Alaska Peninsula and the Susitna Valley.

The Newfoundland data also present conclusive evidence that major variations in the occurrence of twins do occur between areas and that intensive limited-area studies are sometimes required to demonstrate these differences.

The area breakdown of the island-wide observational data shows only two districts, Central with 11 per cent twins in 485 observations and Southern with 24 per cent twins in 154 observations, where significant differences are present. An entirely different picture is presented when the Sandy study-area observational data (Table 3) and a breakdown of the reproductive-tract data (Table 4) are added to the picture. During the 4 years of the Sandy study, 422 observations were made of cows with their calves. Twins were present in only seven instances. The occurrence of twins *in utero* varied from 30 per cent of 53 in the Eastern District to 5 per cent of 151 in the Central District. The differences are even greater if the Sandy-Millertown area alone is considered. In this area only 4 twins were found in 127 uteri. The difference between the occurrence of twins *in utero* in the Eastern District and the Central District is highly significant.

In summary, there is clear evidence that area variation in the occurrence of twins is a common phenomenon. Significant differences are present between observed data collected in several provinces of eastern Canada and in different parts of Alaska and Newfoundland. A highly significant difference in the occurrence of twins *in utero* was also demonstrated for two areas of Newfoundland.

Age Variation in Twinning Rate

I mentioned earlier that in Sweden it is believed that moose give birth to a single calf in their first calving, usually at the age of 3 or 4, and thereafter to twins (Lönnberg, *op. cit.*; Skuncke, *op. cit.*:332). One of the earliest authors on this subject in North America (Stone, *op. cit.*:315) also stated that moose rarely give birth to more than a single calf at their first calving. The recent evidence, based on the occurrence of young *in utero*, permits a somewhat more objective appraisal of this conception, at least for North America. Among Newfoundland's 40 pregnant yearlings, it was possible to determine fetal occurrences in 32, 31 of which were singles (Table 2). In the Milwaukee Zoo, the two animals that bred first as yearlings both gave birth to a single calf at their first calving.

The occurrence of primary corpora lutea in the ovaries of yearlings throws additional light on the matter. Both ovaries were collected from 23 of the pregnant yearlings. In 20 of these a single corpus luteum was present; the other three pairs of ovaries each contained two corpora lutea. The ovaries of nine of the nonpregnant yearlings each contained a single corpus luteum. In total, the ovaries of 28 of 31 yearlings contained a single corpus luteum and the other three pairs contained two each, indicating that twins could have been produced.

The number of young produced by 2-year-old cows that breed for the first time cannot be definitely stated. The problems are two: (1) Age classes, based on tooth erosion (Passmore, Peterson and Cringan, *op. cit.*), may not always correspond to the actual age of the animal, and (2) in Newfoundland, the breeding of yearlings tends to obscure the meaning of corpora albicantia. I endeavored to overcome these problems by combining information on the occurrence of corpora albicantia in the ovaries with the age class. The absence of corpora albicantia in the ovaries of a class II cow carrying twins suggests initial breeding. Both ovaries were collected from five class II cows that were carrying twins (Table 6); all five contained either one or two corpora albicantia. It appears, then, that in this case the twins were all produced by cows breeding for the second time. In the Milwaukee

Zoo population, one cow bred first as a 2-year-old and gave birth to twins the following spring. This is the only definite record that I know of a 2-year-old cow bearing twins on her first calving.

In summary: the Newfoundland and the Milwaukee Zoo data indicate that a very high percentage of the yearling breeders give birth to a single calf. The limited evidence suggests that the same may also be true for 2-year-old animals breeding for the first time.

Occurrence of Triplets

The birth of moose triplets is rare. In Newfoundland, no triplets were observed in the 254 uteri in which the number of fetuses or embryos could be determined. In the 1,579 observations of cows followed by calves, two sets of triplets were observed, one in the Central and one in the Eastern District, both in 1951.

Other North American records of triplets are given by Peterson (1955:56) and by Hosley and Glaser (1952), who reported on three instances of triplets observed in the field, one set in 1946 and the other two in 1947. Peterson concluded that the two 1947 observations were probably of the same animals, for they were observed in the same general area and only 10 days apart.

Skuncke (*op. cit.*:42, 70) gave an interesting account of the occurrence of Swedish triplets. He stated that in Stockholm County one cow produced triplets twice in 16 years; another in Gotland gave birth to triplets three times in exactly the same area; and in still another instance, in Norrland there were two known cases of triplets born in the same place. It appears that in the first two cases the identity of the cow was certain but that in the third case it was not definitely established. Apparently all these instances were reported to Skuncke or were recorded in some publication. (He did not use a formal method of data citation.) He personally knew of four other triplet occurrences, one in Blekinge, one in Ostergotland, and two in Varmland. The two in Varmland were born to the same cow 2 years in succession. Skuncke also reported (*ibid.*: 70) on a fall observation of a cow with quadruplets near Stockholm and pointed out that fall field observations of triplets or quadruplets do not mean that they were all born to the same cow.

The frequency of occurrence of triplets by the same cows (at least three of six cows had triplets at least twice) suggests that a genetic factor may be involved.

COW MOOSE FERTILITY

Prior to the inauguration of moose-reproduction studies based on fall and winter reproductive-tract collections, the only known measure of cow moose fertility was the relative occurrence of cows with and without calves. The percentage of cows with calves is always low in field observations. This phenomenon has long been discussed by woodsmen, as was pointed out by Surber (1940), and the term "barren cow" has become common in the literature on moose. The Nova Scotia study reported by Schierbeck (1929) represented the first quantitative expression of barren cows in a population. His conclusions were based on an observed sample of 6,175 cows, apparently including yearlings, and 3,406 calves. He stated that approximately half of the cows were without calves and pointed to this as a very alarming situation. On the basis of these data Schierbeck, then Chief Forester of the province, convinced the Nova Scotia Department of Lands and Forests that a shortage of bulls existed, and that cows should also be shot. This recommendation was translated into action by the legislature, and in 1927 there was a special hunting season in which 561 cows were killed. Schierbeck stated, ". . . of these 273 were worthless, barren cows."

Since that time, most writers, e.g., Murie (*op. cit.*), Surber (*op. cit.*), Hosley (*op. cit*), Pimlott (1953), Peterson (1955), and Wright (*op. cit.*) have discussed aspects of the question of barren cows. It has generally been shown that at least 50 per cent, usually more, of the observed adult cows were not followed by calves.

Ovulation Rates

The Newfoundland collection of 568 reproductive tracts included 347 pairs of

TABLE 6.—AGE-CLASS INCIDENCE OF PRIMARY CORPORA LUTEA, 1951–56

AGE CLASS[1]	PREGNANT ANIMALS					NONPREGNANT ANIMALS				
	Total Moose	No. of Corpora Lutea			Ovulation Rate	Total Moose	No. of Corpora Lutea			
		One	Two	Total			None	One	Two	Total
I	24	20	4	28	1.2	45	36	9	—	9
II	35	30	5	40	1.1	9	7	2	—	2
III	46	31	15	61	1.3	12	10	2	—	2
IV+	61	46	15	76	1.2	25	11	12	2	16
Age[2]	58	46	12	70	1.2	32	21	10	1	12
Totals and mean	224	173	51	275	1.2	123	85	35	3	41

[1] Age classes after Passmore, Peterson, and Cringan (1955).
[2] Unknown-age class contains only yearling and adult animals.

ovaries from yearling or older cows: 224 pairs were from pregnant cows and 123 pairs from nonpregnant cows (Tables 6, 7). The 347 pairs of ovaries contained 342 corpora lutea, 316 of which I judged to have resulted from ovulated follicles (primary corpora lutea) and 26 from the luteinization of unovulated follicles or of other ovarian structures (accessory corpora lutea). This separation was made on an arbitrary basis: When an ovary contained corpora lutea of two size classes, the smaller ones, those less than half the size of the larger ones, were called "accessory" corpora lutea. With this method of separation, the margin of error would be slight, for usually the smaller corpora were much smaller and were undoubtedly of an accessory nature. To make the corpora lutea counts, the ovaries were cut into slices approximately 2 mm. thick, using a commercial meat slicer (Pimlott and Mossman, 1959).

The ovaries of the 224 pregnant cows contained 275 primary corpora lutea, 173 singles and 51 doubles, for an average of 1.2 per cow (Table 6). The percentage occurrence of double corpora lutea was 23, and significantly higher than the 12 per cent occurrence of twins *in utero*. The ovaries of 38 of the 123 nonpregnant animals contained primary corpora lutea. In these the occurrence of double corpora lutea was much lower, with only 3 in the 38 pairs of ovaries. The combined occurrence of double primary corpora lutea for both the pregnant and the nonpregnant classes was 20 per cent, still significantly higher than the occurrence of twins *in utero*.

The pregnant-cow ovulation rate was lowest, at 1.1 per cow for the Sandy-Millertown area, and highest, at 1.4 per cow, for the Eastern District. The occurrence of double corpora lutea was significantly lower in the Central District than in the remaining districts of the island (Table 7). If only adults are considered, the comparative rates for the two areas are 1.1 and 1.5.

Comparison of the twinning rates (Table 4) and the ovulation rates (Table 7) indicates that the variation of occurrence of twins *in utero* between the various sections of the island was the result of a higher ovulation rate, and not of differential mortality of early embryos.

In two cases where there were twins *in utero*, only a single corpus luteum was present in the ovaries. Apparently this had resulted from the presence of biovular follicles, for in both cases the fetuses were of opposite sexes. Robinette, *et al.* (1955) re-

TABLE 7.—PRIMARY CORPORA LUTEA IN OVARIES OF PREGNANT COW MOOSE, 1951–56

DISTRICT AND AREA	TOTAL MOOSE STUDIED	NUMBER OF CORPORA LUTEA			OVULATION RATE
		One	Two	Total	
Central					
Sandy-M'town	100	90	10	110	1.1
Remainder	18	14	4	22	1.2
Entire district	118	104	14	132	1.1
Western	54	37	17	71	1.3
Eastern	41	24	17	58	1.4
Southern	11	8	3	14	1.3
W-E-S totals	106	69	37	143	1.3
Entire island	224	173	51	275	1.2

ported on three cases of twins *in utero* and only a single corpus luteum in the ovaries of mule deer (*Odocoileus hemionus*). However, in the two cases in which sex could be determined, the fetuses were of the same sex, so it is not definitely established whether these had resulted from biovular follicles or whether they were monozygotic twins.

Pregnancy Rates

In their British Columbia study, Edwards and Ritcey (*op. cit.*) obtained the uteri of 80 cows that were known to be adult. Seventy-five per cent were pregnant. This collection included October-shot animals in which pregnancy would often be difficult, or impossible, to diagnose macroscopically, or that might have bred still later in the season. Their data showed a higher percentage of pregnant animals as the season progressed and suggested that virtually all adult cows were carrying young by the end of the breeding season.

Seventy-five per cent of the adult cow moose collected in Newfoundland were pregnant; however, the pregnancy rate increases to 81 per cent if the November collections are excluded. Since some yearlings breed, it is necessary to consider this age group in the calculations. Sixty-six per cent of the 519 animals in the total collection were pregnant, and this percentage increases to 73 when the November data are excluded (Table 1). These are conservative estimates of the pregnancy rates, since more than 50 per cent of the collection came from the Sandy-Millertown area, where the reproductive rate was low.

The Nova Scotia pregnancy rate of 52 per cent in a sample of 525 cows (Schierbeck, *op. cit.*) was much lower than that for British Columbia (Edwards and Ritcey, *op. cit.*) or Newfoundland. This could be simply a matter of geographic variation. However, there is a more plausible explanation. Schierbeck (*op. cit.*) did not consider the influence on his data of at least one, and possibly two, nonbreeding age classes. In any-sex seasons in Newfoundland, calves and yearlings comprised 40 per cent of the kill over a 4-year period. Since in most areas yearlings do not breed, or at least have a low reproductive rate, I suspect that at least 30 per cent of Schierbeck's "cows" were calves or nonbreeding yearlings. When Schierbeck's data were recomputed on this basis, an estimated 70 per cent of the adult cows were pregnant. This approaches the British Columbia and the Newfoundland averages.

Area variations in pregnancy rates.—The greatest variation in the adult pregnancy rate occurred between that of the Sandy-Millertown area, 61 per cent pregnant in a sample of 166, and that of the Eastern District where 87 per cent of 38 animals were pregnant. However, the Sandy-Millertown data included November collections and the Eastern data did not. When one considers only the December data, the percentages were 74 and 87, respectively, and the difference is not significant. Significant variations did exist in the pregnancy rate for yearling-and-older animals, the December rates being 63 per cent pregnant in a Sandy-Millertown sample of 183, 82 per cent pregnant in an Eastern District sample of 85 (Table 1).

Annual or age variations in pregnancy rates.—Due to the variations between districts and between early- and late-season collections, the data cannot logically be grouped to show annual trends in the pregnancy rates. The individual samples are not large enough to indicate small significant differences, and no obvious variations are present.

The yearling animals had a significantly lower pregnancy rate than the adults, the comparative rates being 37 and 75 per cent, respectively (Tables 1, 2). There were no significant differences in the pregnancy rates of the adult age classes (Table 2).

Barren-cow Percentages as Indicators of Moose Fertility

Observers recorded 2,936 adult-cow observations during the 6 years of the Newfoundland program. Calves were recorded with 36 per cent of these cows (Table 8). In Ontario (Peterson, 1955), Quebec (Moisan, *op. cit.*), and New Brunswick (Wright, *op. cit.*) the percentages were almost identical (Table 8). The percentage of cows observed with calves in the four

TABLE 8.—CO-OPERATOR OBSERVATIONS OF MOOSE IN EASTERN CANADA

Province	Period of Year	Total No. of Adults	No. of Adult Cows	Per Cent ♀♀ with Calves	Number of Calves	Number of Yearlings	Apparent Mortality Rate[1]	Percentage of Yearlings[2]	Reference
Newfoundland	May–Aug.	3,223	1,494	37	674	672	0	17	This study
	Sept.–Dec.	2,656	1,196	36	485	258	47	9	
	Jan.–Apr.	470	246	30	82	87	—	16	
	Entire	6,349	2,936	36	1,241	1,017	22	14	
Ontario	Entire	2,418	1,186	35	526	377	28	13	Peterson, 1955
Quebec	Entire	1,468	792	35	351	153	51	9	Moisan, 1952
New Brunswick	Entire	1,868	987	39	463	318	39	15	Wright, 1956

[1] Derived from the difference between the number of calves and the number of yearlings observed.
[2] Derived from $Y \div (Y + A)$.

areas was less than one-half the percentage of cows found to be pregnant in either the British Columbia (Edwards and Ritcey, *op. cit.*) or the Newfoundland late-season uteri collections.

Since moose observations were made throughout the year, it would seem possible that some of the variation between the pregnant-cow and the observed-cow-with-calf data might be due to seasonal phenomena. For example, if the greatest calf mortality occurs in the early months, late-season ratios would be lower. The Newfoundland data were examined on a monthly and 4-month basis (Tables 4, 8). Apart from the low occurrence of cows with calves during May, no significant differences were present to indicate seasonal variability.

There are two other possible explanations for the marked variation between the pregnant-cow and the observed-cow-with-calf ratios: (1) high mortality *in utero* or soon after birth; (2) observational biases or error, most of which have been previously mentioned (Pimlott, 1953; Peterson, 1955:59, 70).

Effect of fetal and calf mortality on observed ratios.—I have no evidence of high mortality of embryos or fetuses. Of the 283 cases where embryos were present, resorption was definitely diagnosed in only two instances. The comparative occurrence of double corpora lutea and twins, discussed above, suggests mortality of early embryos. However, since this mortality occurs before the embryos are macroscopic, it has already been considered in the pregnancy-rate data. The majority of the uteri were collected in the first 3 months of pregnancy; if high mortality occurred in the months prior to parturition, it would not have been evident.

The results of a study of early-season calf-mortality were discussed in an earlier paper (Pimlott, 1953). The work of the entire Newfoundland program can be summed up by stating that there was no field evidence to suggest that calf mortality was higher than adult mortality. In fact, data from the mandible collection suggest that, prior to the inauguration of any-moose seasons when calves began to be killed by hunters, calf survival was probably higher than that of older age classes. Yearlings comprised 37 per cent of the kill, calves excluded, during the first any-moose season but never more than 26 per cent in subsequent years (Table 10). The trend in the yearling composition was consistent for all areas of the island. This suggests that hunting is the prime calf-mortality factor.

Several investigators have computed average mortality from calf to yearling on the basis of the relative occurrence of calves and yearlings observed in the population. These average mortality rates are estimated as follows: North America, 29 per cent (Peterson, 1955); Ontario, 28 per cent (computed here from Peterson, 1955); Quebec, 51 per cent (Moisan, *op. cit.*); and New Brunswick, 39 per cent (Wright, *op. cit.*). Similarly computed from moose record-card data, the average Newfoundland calf-to-yearling mortality is 22 per cent. These estimates (Table 8), with the exception of the high figure for Quebec, fall within a reasonable range. However, when the Newfoundland

data are broken down, they are completely inconsistent (Table 8). These data indicate an apparent mortality of less than 1 per cent from May to August and 47 per cent from September to December; from January to April more yearlings were recorded than calves. The average of 22 per cent is meaningless—calf mortality that occurred during the previous year could not be zero at one time and 47 per cent 3 months later.

I conclude that (1) there is no evidence that high calf mortality is the reason for the disparity between the fetal ratios and the observed-calf ratios, and that (2) calf-mortality estimates calculated from such ratios are meaningless, as far as Newfoundland is concerned.

Effect of observational biases.—Observational bias is the most important factor in the distortion of population data obtained from field observations. Although Peterson (1955:59, 70) mentioned the possibility that observational bias influences population data, he concluded (1955:59) that it seemed more than a coincidence that the average percentage of calfless cows was so similar across North America. However, in his comparison he included (1955:60) Alaska data, which are dissimilar to those of Newfoundland and Ontario, since the Alaska counts (Spencer and Chatelain, *op. cit.*) were based on late-fall and early-winter observations from aircraft and included yearling cows with the adult cows. I suggest that the similarity existing in the record-card cow-with-calf and yearling percentages in the different areas (Table 8) is more the result of similar observational biases than of any other factor. The biases that most affect observational data are: (1) the secretive behavior of the cow when accompanied by a calf, particularly a young calf; (2) the tendency of the cow to be observed without a calf; and (3) incorrect identification of yearlings. There are no compensatory biases that could operate to offset any of those listed; all act to lower the percentage estimates of cows with calves. The tendency of the cow to be seen without a calf could be due to (1) her leaving the very young calf while she browses, (2) the semi-independent behavior of the cow and calf by late summer or early fall, and (3) the calf not being observed in brushy surroundings.

The evidence that yearlings are frequently identified incorrectly can be discussed quantitatively. In expressing the occurrence of yearlings in the population, Peterson (1955:69) and Wright (*op. cit.*) used "per cent of adults" and "per cent of cows." I prefer to express yearlings as a percentage of yearlings and adults. Computed on this basis, yearlings comprised 13 per cent of the population in Ontario, 15 per cent in New Brunswick, and 14 per cent in Newfoundland. When the Newfoundland data (Table 8) were broken down, the occurrence of yearlings varied from 17 per cent in the first 4-month period (May to August), to 9 per cent in the second, to 16 per cent in the third. The differences between both the first and second periods and the second and third are highly significant. When the data are considered for May and June alone, the differences are even more pronounced, for during these months yearlings comprised 23 per cent of the total yearlings and adults observed. I interpret these data as follows: During the early part of their second year, yearlings can be identified quite readily on the basis of size. However, they grow rapidly and are frequently seen alone, so that observers cannot make accurate yearling:adult size comparisons. This results in overestimation of the number of adults. The percentage of yearlings increases during the winter months because some calves are classified as yearlings.

Two-year-old cows are adult in appearance, and hence, in populations where yearlings do not breed, are part of the barren-cow population. For example, Skuncke (1954) believes that 2-year-old animals comprise 30 per cent of the adult moose population in Sweden. It is obvious that under these circumstances the 2-year-old cows and the mistakenly identified yearlings together could comprise 40 to 50 per cent of the observed-adult-cow population. This aspect of the barren-cow question is frequently overlooked.

PRODUCTIVITY

Lack of knowledge of the productivity of North American moose has resulted in the "barren-cow concept" giving rise to the belief that moose generally are low-fertility, low-productivity animals. This conclusion was strengthened by the history of populations that declined in several areas, e.g., Nova Scotia, New Brunswick, Maine, and Minnesota, where moose were at the southern limit of their range, and where factors other than low productivity were probably the causal ones.

Terminology.—The terminology of big-game reproduction has varied widely from author to author. The word "productivity" is often used by writers who make no attempt to express their results in Leopold's (1933:171) terms as "the rate at which breeding stock produces a removable crop or additional breeding stock." Because of the lack of uniformity of expression present in the literature, I will define the specific productivity terms that will be used here. "Productivity" means the percentage that can be removed yearly without diminishing the population. "Potential productivity" is the theoretical percentage that can be removed if there is no mortality, and "net productivity" the percentage remaining after mortality from causes other than hunting has been deducted. These definitions of potential and net productivity differ from those given by Robinette (1956:415) in that mine have a "harvest" or "yield" connotation, while his definitions have the connotation "population increase."

The terms do not, however, offer an adequate range of description. The potential productivity of Newfoundland moose would be reached if each yearling cow bore a single calf and each adult cow bore twins, and all survived. Because there is no term to describe the intermediate stage of herd production which would be attained if all embryos *in utero* at the end of the breeding season survive, the term "gross productivity" will be used. The terms "gross and net productivity" used in this paper are synonymous with "total and net production" as defined by The Wildlife Society's Committee on Wildlife Terminology (1957). "Rate of increase" is the percentage obtained when the increment to a population is divided by the original population. This term can also be modified by the use of "potential" and "net."

Methods of measuring net productivity.—Robinette (*op. cit.*:420–422) reviewed the various methods that have been used to measure the net productivity of big-game populations. Only the methods that can be used in the absence of population estimates will be discussed here.

In areas where any-moose seasons are in effect and where calves are being harvested by hunting, it would seem desirable to base estimates of net productivity on the occurrence of calves in the fall population. The aerial surveys conducted in Alaska (Spencer and Chatelain, *op. cit.*) demonstrate the feasibility of this method of obtaining fall-calf data on at least some western moose range. Aerial work in Newfoundland has led me to conclude that a comparable method is not feasible on well-wooded eastern range. The additional facts that field observations do not give reliable calf data, and that hunters select against calves during any-moose seasons so that these animals do not occur in normal proportions in the kill mean that no direct method has yet been devised for measuring net productivity at the calf level on eastern range.

The occurrence of yearlings in big-game populations is usually considered to be the best measure of herd productivity (Robinette and Olsen, 1944; Rasmussen and Doman, 1947; Peterson, 1949). Peterson was the first worker to use this statistic for a moose population, computing it on the basis of observed data. Some of the biases and limitations of this type of data have been discussed above. A more objective method of obtaining data on the occurrence of yearlings in the population is the aging of legally killed animals.

The method of computing productivity on the basis of the occurrence of yearlings has been quite variable. Robinette and Olsen (*op. cit.*) computed it as the percentage of yearlings and adults: $Y \div (Y + A)$. Rasmussen and Doman (*op. cit.*) computed it

TABLE 9.—GROSS PRODUCTIVITY AND INCREASE RATES FOR THREE MOOSE POPULATIONS

AREA	ADULT SEX RATIO	REPRODUCTIVE RATES[1]		HERD COMPOSITION[2]			GROSS PRODUCTIVITY[3] (PER CENT)	RATE OF INCREASE[3] (PER CENT)	PER CENT OF REPRODUCTION BY YEARLINGS[3]
		YEARLINGS	ADULTS	C	Y	A			
Newfoundland[4]									
Eastern	53:47	0.7	1.2	26	21	53	27	37	19
Sandy-M'town	51:49	0.3	0.8	21	17	62	21	27	9
Island-wide	52:48	0.5	1.0	22	18	60	25	33	13
Br. Columbia[5]	50:50	—	1.2	22	18	60	26	36	—
Sweden[6]	44:56	—	1.3	29	21	50	26	37	—

[1] The reproductive rates were obtained by dividing the total number of fetuses by the total females in the sample.
[2] Winter population of calves (C), adults (A), and yearlings (Y) expressed as percentages.
[3] Computed from sex ratio, reproductive rate and herd composition data given in table.
[4] Observed sex ratios (Pimlott, 1959); herd composition based on adjusted kill data (Table 10).
[5] Sex ratio and herd composition are assumed values. Reproductive rates are based on December-and-later data from Edwards and Ritcey (1958:Table 3).
[6] From, or based on, Skuncke (1954).

as the percentage of yearlings in the whole population: $Y \div (C + Y + A)$. Peterson (1949, 1955:70, 216) computed it as the percentage of adults ($Y \div A$), and referred to it as the average annual increment to the adult population. Any one of these three methods can provide a useful statistic, but in terms of the original definition of productivity (the percentage that can be removed yearly without diminishing the population), only the Robinette and Olsen (*op. cit.*) formula is satisfactory. When calves are considered as the measure of net productivity, the formula $C \div (C + Y + A)$ provides the same measure of productivity.

Gross productivity.—In Table 9, gross productivity and increase rates are given for Newfoundland, British Columbia, and Sweden. The rates for Newfoundland are based on December-and-later reproductive-tract collections. The sex and age ratios are based on kill and observed data. The rates for British Columbia are based on December-and-later reproductive-tract collections, as reported by Edwards and Ritcey (*op. cit.*). However, the sex ratio and population composition are assumed values. The population sex ratio, composition, and rate of increase for Sweden were given by Skuncke (1954). The adult female reproductive rate and the gross productivity rate I calculated from his data. Skuncke's productivity calculations are not based on reproductive-tract collections. However, the rate of population increase reported for Swedish moose (Hamilton, 1953; Wennmark, 1958) and the very high yields convince me that the gross productivity of this herd must be high.

The Newfoundland data show the gross productivity of moose in the Eastern District to be one-fourth higher than that for moose occurring in the Sandy-Millertown area (Table 9). The pregnancy rate and the twinning rate of these two areas have been shown to differ significantly. The rates for Newfoundland, British Columbia, and Sweden, as calculated in Table 9, are of the order of 25 per cent. In the Newfoundland population, approximately 10 to 20 per cent of the calves were produced by the cows that bred as yearlings.

Net productivity.—Fifteen per cent of the 2,017 moose mandibles collected during the 1953–56 hunting seasons were from calves (Table 10). Because this age class contributes substantially to the legal kill, it must be considered in computations of net productivity. Since there is no direct means of estimating net productivity from the fall calf population, it will be estimated here from the occurrence of yearlings in the kill and from field-observation data.

Identification bias has the least influence during the late spring and early summer. During May, June, and July, yearlings comprised 27, 20 and 15 per cent (average 20 per cent, Table 11), respectively, of the yearling and adult observations. The inclusion of the July observations ensures that the average is a conservative estimate of the yearling statistic for this period of the year;

TABLE 10.—OCCURRENCE OF CALVES AND YEARLINGS IN THE POPULATION, ESTIMATED FROM KILL DATA[1]

YEAR	DISTRICT	PER CENT CALVES[2]		PER CENT YEARLINGS[2]					
		$\frac{C}{C+Y+A}$		$\frac{Y}{C+Y+A}$		$\frac{Y}{Y+A}$		$\frac{Y}{A}$	
		Actual	Adjusted[3]	Actual	Adjusted	Actual	Adjusted[3]	Actual	Adjusted
1953	Central	14	23	30	21	35	27	54	37
	Western	17	21	26	19	31	24	46	32
	Eastern	17	28	36	25	44	35	78	54
	Southern	16	24	30	21	36	28	57	39
	Mean	16	24	31	22	37	29	58	40
1954	Central	14	20	20	15	23	19	31	23
1955	Central	6	22	25	17	26	21	35	27
	2-year mean	10	21	22	16	25	20	33	25
1956	Central	10	20	21	15	23	19	31	23
	Western	17	17	17	13	17	15	26	18
	Eastern	21	23	24	18	30	23	43	30
	Southern	11	18	20	13	22	16	29	19
	Mean	16	21	22	16	26	20	35	25
1953–56	All samples	15	22	25	18	30	23	42	30
1953–56	Central	11	21	24	17	27	21	36	27
1953 and 1956	Eastern	20	26	29	21	36	28	55	39

[1] Adjusted kill data allow for yearlings being 1.8 times as vulnerable as adults during the first 3 weeks of the season and 1.4 times as vulnerable during the second 3 weeks. They also allow for a fall-calf to fall-yearling mortality of 10 per cent in 1953 and 25 per cent thereafter.

[2] Based on a collection of 763 animals in 1953, 243 in 1954, 220 in 1955, and 791 in 1956.

[3] Also population net-productivity estimates.

it compares quite closely with the values provided by kill data that will be discussed in this section. The observed data do not show the significant variation between the Central and Eastern districts that is evident in the kill data. This may simply be that the kill data were collected in the Sandy-Millertown section of the district, while the observational data were collected throughout the entire district, where a higher rate of reproduction may occur.

The island-wide occurrence of yearlings in the kill was 31 per cent in 1953 and 22 per cent in 1956 (Table 10); the difference is significant. The variation between years is of similar magnitude in all districts. Yearlings comprised 25 per cent of the island-wide total for the 4-year period. The kill data do not include calves in normal proportions; hence the calf percentages in Table 10 are underestimations of the population and the yearling percentages are overestimations. To obtain a more normal representation of age classes in the population, the kill data were first adjusted to allow a mortality of 10 per cent from fall calf to yearling in 1953, and a mortality of 25 per cent for each of the three following years when calves were being shot. After this adjustment, yearlings were estimated to comprise 26, 18, 19, and 19 per cent of the populations represented by the kills in 1953, 1954, 1955, and 1956, respectively, while calves comprised 29, 24, 26, and 26 per cent, respectively. The percentage of calves in these adjusted data is close to the estimated gross productivity rates discussed above. This

TABLE 11.—PERCENTAGE OF YEARLING MOOSE SEEN IN NEWFOUNDLAND, 1950–55[1]

MONTH SEEN	SAMPLE SIZE	PER CENT YEARLINGS		
		$\frac{Y}{Y+A}$	0.05 C.L.	$\frac{Y}{A}$
May	994	27	24–30	36
June	1,308	20	18–23	25
July	1,206	15	13–17	19
May–June	3,508	20	19–21	25

[1] Based on moose record-card and field-party data, but does not include Sandy study-area data.

TABLE 12.—PERCENTAGE OF YEARLING MOOSE IN THE NEWFOUNDLAND KILL, 1953–56

Week of Season	Sample Size	Per Cent Yearlings	0.05 C.L.
1	349	30	25–35
2	213	34	28–40
3	188	29	21–37
3-week total	750	31	28–35
4	134	24	16–33
5	100	22	14–31
6	75	20	11–32
3-week total	309	22	17–27
7 to 9 weeks	49	10	3–22
Entire season	1,108	27	24–30

suggests that the percentage of yearlings was higher in the kill than in the population.

The date of kill was known for 1,108 yearlings and adults. These data were broken down into weekly periods (Table 12). A chi-square test indicated that a highly significant variation existed in the distribution of the age classes. When divided into 3-week periods, yearlings comprised 31 per cent of the kill during the first 3 weeks, and 22 per cent during the second. Because the sample during the last 3 weeks consisted of only 49 animals, no significance can be attributed to the 10 per cent occurrence of yearlings. The data indicate that yearlings are more vulnerable to hunting than adults, so that, without adjustment, the cumulative age ratio cannot be used as a measure of the percentage of yearlings in the population.

Hickey (1955:351) has pointed out that when the percentage of young is steadily shrinking in hunters' bags throughout the autumn, the ratio of young:adults will always be higher among the dead than among the living. I adapted Hickey's method and established hypothetical populations in which yearlings comprised 25, 20, and 15 per cent of the yearling and adult population. The yearlings were then subjected to vulnerability factors that ranged from 1.2 to 2.8 times the vulnerability of the adults. These facts became evident: (1) The variation between the first and second 3-week periods could not be achieved when the vulnerability factor remained constant throughout the hunting season. This suggested a two-stage factor. (2) When 25 per cent of the population consisted of yearlings, kill percentages could be achieved when the yearlings were subjected to a vulnerability factor of 1.4 during the first 3 weeks, and when they were considered no more vulnerable than the adults in the last 3 weeks. In the population in which yearlings constituted 20 per cent, the kill percentages could also be approximated when yearling vulnerability factors of 1.8 and 1.4 were used for the first and second 3-week periods. When 15 per cent of the population consisted of yearlings, vulnerability factors of 2.8 and 2.4 were required to achieve the kill percentages. The percentages of class II animals in the kill, and my knowledge of yearling behavior, suggested that this is an unrealistic hypothesis, and I rejected it. (3) The rate of exploitation, within possible limits, had virtually no effect on the outcome of the calculations.

The model-population data suggest a means of adjusting the yearling percentages in the kill. There is, however, no completely objective method of determining which pair of vulnerability factors, i.e., 1.4 and 1.0, or 1.8 and 1.4, is closer to reality. In considering the problem in the light of Newfoundland hunter densities and hunting conditions, I concluded that it was most likely that a differential vulnerability factor would operate throughout the first half of the hunting season. This led to the selection of the 1.8 and 1.4 factors as the more likely pair. The use of this pair gives more conservative net-productivity estimates (Table 10).

In areas other than the Sandy-Millertown section of the Central District, a 4-week hunting season was the rule during the collection period. If the vulnerability factors operate as they appear to in the population model, a proportionately higher percentage of yearlings would have been killed in the short-season areas than in the long-season areas. The population model indicated that in the long- and short-season areas the yearling percentages should be decreased by 25 and 30 per cent, respectively, with vulner-

ability factors of 1.4 and 1.0. The yearling percentages were obtained, as in the previous calculations, by assuming a 10 per cent mortality from fall calf to fall yearling in 1953, and 25 per cent mortality thereafter (Table 10). The fall-calf percentages in Table 10 are also the estimates of net productivity of Newfoundland moose. The island-wide net-productivity estimate for 1953 is 24 per cent and for 1956 is 21 per cent. The estimate for the Eastern District is 26 per cent and for the Central District 21 per cent.

In summary, these data indicate that 20 to 25 per cent is a conservative estimate of the net productivity of Newfoundland moose. This rate is approximately double that suggested by Peterson (1955:216) for North American moose. He stated, on a basis of the ratio of yearlings:adults ($Y \div A$), that the average annual increment falls between 12 and 25 per cent, and averages 16 or 17 per cent. The island-wide adjusted average for the 1953–56 period is 30 per cent and is as high as 54 per cent in the Eastern District (Table 10). After 1953, the yearling:adult ratios give low estimates of increment because of the reduction of the calf population by legal hunting, but are commonly higher than 25 per cent.

Spencer and Chatelain (*op. cit.*) made 9,436 aerial observations of moose in four Alaskan areas from November to January in three consecutive years. The following statistics are computed from their data. The sex ratio of the 5,319 animals observed during November surveys was 36♂:64♀. Calves comprised 17 per cent of all animals observed. The productivity of the Kenai Peninsula moose was particularly low; calves comprised only 10 per cent of 3,807 animals observed. In the Susitna Valley, calves comprised 23 per cent of 4,428 moose observed. The difference in the calf percentages in these two areas was highly significant. In the other two areas, Copper River and Alaska Peninsula, the calf percentages were intermediate.

Skuncke (1949:307) gives the calf percentages obtained in winter censuses in 1936 and 1937–38 in the Hallefors region of Sweden. In 1936, calves comprised 35 per cent of the animals observed, and in 1937–38, 32 per cent. Between 800 and 900 animals were included in the two samples. Skuncke further states that the figures agree with later counts made in central Sweden after the hunting season, during a period when calf hunting was illegal. When I adjusted the data to allow for a 20 per cent kill of adults, calves comprised between 25 and 30 per cent of the fall population. Skuncke (1949:340) implied that the net productivity was of this magnitude, for he stated that 25 per cent of the animals must be harvested to prevent a moose population from increasing. The 25 per cent figure is also used by Wennmark (1955) in making allowance for annual increases in population estimates, and is borne out by annual yields which can be computed from population data given by Hamilton (*op. cit.*). These data from Sweden, Alaska, and Newfoundland indicate that a net productivity of 25 per cent is to be expected on good range.

Factors influencing productivity.—In previous sections of this paper, it has been shown that moose reproduction and productivity in the Eastern District are significantly higher than in the Central District, which was represented mainly by data from the Sandy-Millertown area. Similar differences may exist between other sections of the island, but the samples were too small to demonstrate them. For these reasons, this discussion will be limited to the Sandy-Millertown area and the Eastern District.

Although the causes of the marked variation in reproduction between the two areas are not clearly evident, there are contrasts that point to possible influents.

1) Moose were first reported in the Sandy-Millertown area almost 40 years ago; in many parts of the Eastern District they have a recorded occurrence of less than 25 years, and have only recently completed the colonization of the district (Pimlott, 1953).

2) Moose density in the Sandy-Millertown area is considerably higher than in any section of the Eastern District. Density variation cannot be stated in precise terms but was evidenced by comparative field studies,

hunter success, average length of hunts, and by intensity of browsing.

3) In many parts of the Eastern District, full-scale hunting commenced within a decade of the time moose were first reported. In spite of the apparent density variations, the average exploitation rate for the Eastern District has now exceeded that of the Sandy-Millertown area.

4) In 1953, a forest browse-damage survey of cutover areas was conducted in several sections of the island (Pimlott, 1955). The Sandy River area (Central District) and the Terra Nova area (Eastern District) were included. The cutovers there are well distributed and provide most of the winter range. The survey showed no evidence of food shortages in either area. Balsam fir (*Abies balsamea*), the most available winter-browse species, was 18 per cent browsed in the Terra Nova area and 16 per cent browsed in the Sandy area. White birch (*Betula papyrifera*), which comprised approximately 75 per cent of the available deciduous browse in both areas, was much more heavily browsed in the Sandy area than in the Terra Nova area. Eighty-eight per cent of the young growth was browsed at Sandy and 40 per cent at Terra Nova. Browsing on most other deciduous species in the two areas was of comparable intensity. Although winter starvation does not occur in the Sandy area, the heavy browsing of deciduous species may result in nutritional deficiencies.

Variation in the rate of reproduction of ungulates has been demonstrated for a number of areas and has usually been attributed to qualitative and quantitative changes in the food supply. In New York, a preliminary study of white-tailed deer (*Odocoileus virginianus*) by Morton and Cheatum (1946) and more detailed work by Cheatum and Severinghaus (1950) showed that a decrease in the number of embryos per doe was broadly related to range quality. The latter workers concluded that the paramount factor was probably the relative availability of nutritive foods during the winter. In Washington, Buechner and Swanson (1955) found a high percentage of pregnant yearling elk (*Cervus canadensis*), following herd reduction in the Blue Mountains. An interesting aspect of their findings was that the increase apparently was as high in a watershed where range conditions were poor as on other ranges in better condition, although the poorer range did not improve appreciably following herd reduction. They suggested that this increased natality was due to the same amount of food being utilized by fewer animals.

Edwards and Ritcey (*op. cit.*) believed that moose summering at higher elevations have a higher twinning rate than those summering in the valleys. They postulated that since all animals live on essentially the same winter range, this difference must be associated with variations in the summer environment. They pointed out that studies of domestic sheep (Stoddard and Smith, 1943: 40; Belschner, 1951:204), and of mule deer (Longhurst, Leopold, and Dasmann, 1952), indicate that the ovulation rate is greatly affected by the nutritional level prior to, and during, the breeding season.

In the British Columbia study of moose, the adult pregnancy rate and the twinning rate appear to be higher than the Newfoundland average. However, breeding yearlings are common in Newfoundland but are not reported for British Columbia (Edwards and Ritcey, *op. cit.*). If, as suggested, the adult ovulation rate is especially influenced by the nutritional level before, and during, the breeding season, it is likely that a different factor controls yearling breeding. I believe that this factor is winter nutrition. On western winter ranges, moose are much more restricted and occur in much higher densities, food conditions are probably poorer, and competition for food more intense, than on Newfoundland range where the animals are widely dispersed. Precocial sexual maturity is undoubtedly a reflection of early physical maturity, and yearling growth and development must be greatly influenced by food conditions during the animals' first winter. It seems probable that the breeding of elk yearlings (Buechner and Swanson, *op. cit.*) was similarly controlled, and that with decreased competition on the

winter range, calves received more than a proportional increase in food.

In the case of the adult cow moose, it is difficult to support a hypothesis that the marked difference between the adult twinning rates for the Sandy-Millertown area and for the Eastern District is caused solely by variations in the summer nutritional level. No clear-cut environmental differences exist between the two areas, such as exist between the mountain and valley habitats described by Edwards and Ritcey (*op. cit.*). Moose on summer range have a wide variety of available food and utilize a much greater number of plant species than in winter. I do not believe that a difference of one or two moose per square mile would significantly affect the availability of even the choicest summer foods. If summer nutrition is the important factor, there must be other variables associated with the environments that are also active. I suspect that adult ovulation is controlled by the complex interaction of winter and summer nutritional factors, which may vary from range to range.

SUMMARY

Reproduction and productivity of Newfoundland moose were studied over a 7-year period from 1950 to 1956. The results are based on more than 13,000 field observations of moose, and on 2,017 mandibles and 561 uteri that were largely obtained from hunters' kills.

Thirty-seven per cent of the 107 yearlings collected were pregnant; of the 78 that were collected in December or later, 46 per cent were pregnant. The occurrence of corpora lutea in the ovaries of nonpregnant animals suggested that 60 per cent of all yearling females came into breeding condition. Two of three healthy females raised in the Milwaukee Zoo bred first as yearlings.

The frequency of twinning for Newfoundland moose was 15 per cent when based on field observations and 12 per cent when based on uteri data. A high moose-density section of the Central District had a twinning rate of less than 5 per cent, while in the Eastern District the average was 30 per cent. One pregnant yearling in 32 was carrying twins; two others had ovulated two follicles each. Significant variations in the twinning rate for older age classes were not demonstrated. No triplets were observed *in utero*; two sets were reported by record-card observers.

Among 347 pairs of ovaries collected from yearling and older cows, 224 were from pregnant cows and contained 275 primary corpora lutea. The average occurrence of two corpora lutea was almost twice as high as the occurrence of twins *in utero*. Two instances of twins occurring from a single ovulation were recorded. The adult pregnancy rate was 76 per cent when computed for the entire uteri collection and 81 per cent with November data excluded. The pregnancy rate for yearlings and older animals was 66 per cent and, with the November data excluded, 73 per cent. The animals collected in the Eastern District had a significantly higher pregnancy rate than animals collected from the remainder of the island.

The percentage of cows observed with calves (35) was approximately half the percentage of pregnant cows (73), the difference being caused by observational biases that pose a serious problem in the use of observed-cow-with-calf and yearling percentages. Calf mortality in Newfoundland was judged to be of a low order.

Gross productivity of Newfoundland moose, based on fetal occurrence, was between 23 and 32 per cent. Net productivity was between 20 and 25 per cent when expressed as the percentage of calves in the fall population. Yearlings were more vulnerable to hunting than adults and occurred in abnormally high proportions in the kill. Kill data, therefore, must be adjusted before they can be used to assess net productivity of this species.

The nutritional level during a female moose's first winter is probably the most important factor in the breeding of yearlings. On winter range where there is a concentration of moose, direct competition may result in calves being unable to obtain adequate food—to the detriment of their physical development and of their breeding (as yearlings) the next fall. Variations in adult

fecundity may be caused by a number of nutritional factors that differ from one range to another.

REFERENCES CITED

BELSCHNER, H. G. 1951. Sheep management and diseases. Sydney, Australia: Angus and Robertson. x+723pp.

BUECHNER, HELMUT K. AND CARL V. SWANSON. 1955. Increased natality resulting from lowered population density among elk in southeastern Washington. Trans. N. Amer. Wildl. Conf., 20:560–567.

CHEATUM, E. L. AND C. W. SEVERINGHAUS. 1950. Variations in fertility of white-tailed deer related to range conditions. Trans. N. Amer. Wildl. Conf., 15:170–190.

DODDS, DONALD GILBERT. 1955. A contribution to the ecology of the moose in Newfoundland. Unpub. M.S. thesis. Cornell Univ., Ithaca, N.Y. 116pp.

———. 1958. Observations of pre-rutting behavior in Newfoundland moose. J. Mammal., 39(3):412–416.

EDWARDS, R. Y. AND R. W. RITCEY. 1958. Reproduction in a moose population. J. Wildl. Mgmt., 22(3):261–268.

HAMILTON, HARRY. 1953. Älgstammens storlek. Svensk Jakt, 91(6):204–206.

HATTER, JAMES. 1950. The moose of central British Columbia. Unpub. Ph.D. thesis, State College of Wash., Pullman, Wash. 359pp.

HICKEY, JOSEPH J. 1955. Some American population research on gallinaceous birds. Pp.326–381 *in* Recent studies in avian biology, ed. by Albert Wolfson. Urbana: Univ. Ill. Press. ix+479pp.

HOSLEY, N. W. 1949. The moose and its ecology. U.S. Fish and Wildl. Serv., Leaflet 312. 51pp.

——— AND FRANK S. GLASER. 1952. Triplet Alaskan moose calves. J. Mammal., 33(2):247.

LEOPOLD, ALDO. 1933. Game management. New York: Charles Scribner's Sons. xxi+481pp.

LONGHURST, W. M., A. S. LEOPOLD, AND R. F. DASMANN. 1952. A survey of California deer herds, their ranges and management problems. Calif. Dept. Game and Fish, Game Bull. No. 6:1–136.

LÖNNBERG, EINAR. 1923. Sveriges jaktbara djur. Svenska Jordbrakets bok. Häft. 1. Stockholm: Albert Bonnier. 65pp. (Original not seen; quoted from Peterson, 1955.)

MERRILL, SAMUEL. 1916. The moose book. New York: E. P. Dutton and Co. 366pp.

MOISAN, GASTON. 1952. Investigation on moose population. Pp.25–43 *in* General report of the Minister of Game and Fisheries . . . for the fiscal years 1950–51 and 1951–52. Quebec Dept. of Fish and Game. 151pp.

MORTON, GLENN H. AND E. L. CHEATUM. 1946. Regional differences in breeding potential of white-tailed deer in New York. J. Wildl. Mgmt., 10(3):242–248.

MURIE, ADOLPH. 1934. The moose of Isle Royale. Univ. Mich., Mus. Zool., Misc. Pub. 25. 44pp.

PASSMORE, R. C., R. L. PETERSON, AND A. T. CRINGAN. 1955. A study of mandibular tooth-wear as an index to age of moose. Appendix A. Pp.223–246 *in* North American moose, by Randolph L. Peterson. Toronto: Univ. Toronto Press. xi+280pp.

PETERSON, RANDOLPH L. 1949. Management of moose. Proc. Conv. Internat. Assoc. Game, Fish and Cons. Comm., 39:71–75.

———. 1955. North American moose. Toronto: Univ. Toronto Press. xi+280pp.

PIMLOTT, DOUGLAS H. 1953. Newfoundland moose. Trans. N. Amer. Wildl. Conf., 18: 563–581.

———. 1955. Moose and the Newfoundland forests. A report to the Newfoundland Royal Commission on Forestry. Wildl. Div., Nfld. Dept. Mines and Res. 26pp. (mimeo.)

———. 1959. Moose harvests in Newfoundland and Fennoscandian countries. Trans. N. Amer. Wildl. Conf., 24: in press.

——— AND W. J. CARBERRY. 1958. North American moose transplantations and handling techniques. J. Wildl. Mgmt., 22(1):51–62.

——— AND H. W. MOSSMAN. 1959. A macroscopic ovary-sectioning method. J. Wildl. Mgmt., 23(2):232–233.

RASMUSSEN, D. I. AND EVERETT R. DOMAN. 1947. Planning of management programs for western big-game herds. Trans. N. Amer. Wildl. Conf., 12:204–211.

ROBINETTE, W. LESLIE. 1956. Productivity—the annual crop of mule deer. Pp.415–429 *in* The deer of North America, ed. by Walter P. Taylor. Harrisburg, Pa.: The Stackpole Co. xvi+668pp.

——— AND ORANGE A. OLSEN. 1944. Studies of the productivity of mule deer in central Utah. Trans. N. Amer. Wildl. Conf., 9:156–161.

———, JAY S. GASHWILER, DALE A. JONES, AND HAROLD S. CRANE. 1955. Fertility of mule deer in Utah. J. Wildl. Mgmt., 19(1):115–136.

SCHIERBECK, OTTO. 1929. Is it right to protect the female of the species at the cost of the male? Canad. Field-Nat., 43(1):6–9.

SERGEANT, D. E. AND DOUGLAS H. PIMLOTT. 1959. Age determination in moose from sectioned incisor teeth. J. Wildl. Mgmt., 23(3):315–321.

SETON, ERNEST THOMPSON. 1929. Lives of game animals. Vol. 3. New York: Doubleday, Doran & Co. xix+780pp.

SKUNCKE, FOLKE. 1949. Älgen. Studier jakt och vård. Stockholm: P. A. Norstedt & Söners. 400pp.

———. 1954. Älgstammens tillväxt. Svensk Jakt, 92(1):15–17.

SPENCER, DAVID L. AND EDWARD F. CHATELAIN. 1953. Progress in the management of the moose in south central Alaska. Trans. N. Amer. Wildl. Conf., 18:539–552.

STODDARD, L. A. AND A. D. SMITH. 1943. Range management. New York: McGraw-Hill Book Co. vii+547pp.

STONE, ANDREW J. 1902. The moose, where it lives and how it lives. Pp.291–325 *in* The deer family, by Theodore Roosevelt, T. S. Van Dyke, D. G. Elliot, and A. J. Stone. New York: Macmillan. ix+334pp.

SURBER, THADDEUS. 1940. Minnesota moose—then and now. Cons. Volunteer, 1(1):41–44.

WENNMARK, TORSTEN. 1955. Älgskadorna och älgjakten 1954. Svensk Jakt, 93(6):176–179.

———. 1958. Återblick på älgavskjutningen. Svensk Jakt, 96(3):87, 88, 120.

WILDLIFE SOCIETY COMMITTEE ON WILDLIFE TERMINOLOGY. 1957. Glossary of wildlife terms. J. Wildl. Mgmt., 21(3):373–376.

WRIGHT, BRUCE S. 1956. The moose of New Brunswick. A report to the Minister of Lands and Mines, N.B. 63pp. (mimeo.)

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THE AGE OF SELF-SUFFICIENCY IN THE BLACK BEAR[1]

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The age at which young game animals become self-sufficient is little known. Yet this can be important in game management. A hunting season which permits killing the mother before the young become self-reliant necessarily results in the loss of her young as well. Transplanting young animals may be more practical than moving adults, providing the young are self-sufficient. For example, it may be quite easy to capture the young of species difficult to trap or handle as adults. Also it may be desirable to transplant animals exhibiting strong homing tendencies before this characteristic expresses itself. Several of these considerations are important in management of the black bear (*Ursus americanus*) in northern Michigan.

This paper reports experiments to determine whether black bear cubs 5 to 8 months old can survive by themselves in Michigan's Upper Peninsula when released from the steel traps of predator trappers or when orphaned by hunters. Many dams apparently abandon trapped cubs (Erickson, 1957); and Michigan's early bearhunting season, traditionally open September 1, is responsible for some orphanned cubs.

METHODS

To determine whether cubs deprived of their mothers could survive, I released certain cubs (experimental animals) far enough from their point of capture to insure that they would not find their mothers. I then released others (controls) at the point of capture, presumably to return to their mothers. The proportion of these cubs recovered subsequently (by hunters and my own live-trapping) indicated the comparative survival. Recoveries 2 weeks or longer after release were considered adequate evidence of sulf-sufficiency. As a further test I released cubs on "bearless" islands in Lake Michigan where survival over winter was considered proof of self-sufficiency.

In the summers of 1955–57, 23 experimental cubs were released in Michigan's Upper Peninsula—20 (12 males, 8 females) on the mainland in Alger and Schoolcraft Counties, in moderately good to excellent bear range, and 3 (2 males, 1 female) on Poverty and Big Summer Islands in Delta

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County. In the summers of 1956–57, 12 control cubs (8 males, 4 females) were released on the mainland. Nine of the experimental animals were obtained from coyote bounty trappers, 3 from persons illegally holding captives, and 11 were live-trapped. Eleven of the control cubs were live-trapped for the study and the other was captured by accident in a coyote set.

In order to prevent experimental cubs from rejoining their mothers, they were released in areas remote (up to 175 miles) from their points of capture. My previous experience with the movements of live-trapped bears indicated that even the two cubs released nearest to point of capture (about 4 miles) were not likely to rejoin their mothers. Actually the mothers of five were dead. Control cubs were released where captured. In 10 cases the mother was seen to accompany the cubs. Fresh sign indicated that the mother was also present at the other two releases. Metal ear tags marked both control and experimental animals.

Extreme dates of release of the experimental cubs were July 6 and September 29; of controls, June 21 and September 22. If we assume that the released cubs were born about February 1 (Seton, 1929; Aldous, 1937; Burt, 1948; Matson, 1954), their ages ranged between 5 and 8 months at time of release. My only two records for parturition are for the last week of January and February 14. I believe that the assigned ages (Tables 1, 2) are accurate to about two weeks.

At the time of release, the cubs varied markedly in size and physical condition. Weights of the 23 experimental cubs ranged from 18 to 81 pounds (average 31); the 12 control cubs, from 18 to 44 pounds (average 27). The weight difference between experimental and control animals was due, for the most part, to my holding seven test cubs briefly as captives before release. Since captives were provided with ample food, they made substantial weight gains. One retained for 3 months increased from 12 to 81 pounds. Exclusive of captives, 16 test

TABLE 1.—RELEASES AND RECOVERIES OF 20 BEAR CUBS RELEASED ALONE[1]

Estimated Age (months)	Sex	Weight at Release (pounds)	Date of Release	Time Lapse until Recovery (days)	Manner Recovered	Distance Transferred (miles)	Remarks
5½	F	25	7/15/57	88	Shot	17	Lacerated foot; orphan; held 6 days
6	M	39	7/20/57			49	Amputated foot; held 19 days
6	F	27	7/21/57			19	Orphan
6	F	21	7/23/56	117	Shot	15	Lacerated foot
6	F	20	7/30/57			176	Amputated foot
6	M	39	8/ 5/56			4	
6	M	25	8/ 6/56	102	Shot	14	
6	M	29	8/ 9/56			119	Amputated foot; held 61 days
6½	M	25	8/15/56			4	Fractured mandibular suture; held 15 days
6½	F	26	8/18/55			36	
7	F	19	8/22/57			15	Orphan
7	M	18	8/22/57			15	Orphan
7	M	20	8/22/57			15	Orphan
7	M	18	8/23/57	47	Shot	165	Amputated hind foot
7	M	38	8/26/57			12	
7	M	35	8/30/57	17	Live-trap	38	
7	M	26	9/ 6/56			8	
7½	M	81	9/19/55	391	Shot	100	Amputated foot; held 3 months
8	F	34	9/20/56			58	
8	F	45	9/29/56	54	Shot	35	

[1] Three cubs released on islands not included.

TABLE 2.—RELEASES AND RECOVERIES OF 12 BEAR CUBS RELEASED WITH THEIR DAMS

Estimated Age (months)	Sex	Weight at Release (pounds)	Date of Release	Time Lapse until Recovery (days)	Manner Recovered	Remarks
5½	M	18	6/21/57			
5½	M	18	6/21/57			
6	M	22	7/26/56			Lacerated foot; retrapped 8/8/56 but not considered in this analysis
6	F	25	7/26/56			
6	M	25	8/ 9/57			Lacerated foot
6	F	24	8/10/56			Lacerated foot
6½	M	27	8/13/57			Lacerated foot
6½	M	22	8/14/56	95	Shot	
6½	M	26	8/14/56	95	Shot	
6½	M	29	8/17/56	348	Retrapped	Lacerated foot
7	F	38	8/27/56	82	Shot	Broken radius and ulna; fracture mended when recovered
7½	F	44	9/22/57			Fractured leg

cubs averaged 27 pounds, or the same as the controls.

Physical injuries to cubs in the study were frequent. Five experimental animals suffered foot amputations; two had foot lacerations and one a broken jaw (fractured mandibular suture). The controls included five with lacerated feet and two with broken legs. Steel traps inflicted the foot and leg injuries. The foot amputations were necessitated by complications, arising from minor injuries, resulting from infrequent inspection of traplines by bounty trappers. In my own experience, steel trapping is not unduly injurious if one inspects his traps often. The jaw fracture apparently occurred when the cub struggled to free itself from the trap.

MAINLAND RELEASES

About one-third of the cubs were recovered, whether released on their own or in company with their dams. Of 20 experimental cubs released on their own in Alger and Schoolcraft Counties, 7 were recovered, 6 during the fall following release and 1 the second fall after its release (Table 1). The proportion of returns from control cubs released with their mothers nearby (4 of 12) was quite similar (Table 2). Three of these cubs were recovered the fall after release, and one the next summer. Recovery intervals ranged from 17 to 391 days following release, and averaged 116 days for test animals and 155 days for controls.

The fact that over a third of the test cubs were recovered is significant evidence that they survived and were self-sufficient to a considerable degree. Their recovery at about the same rate as the controls indicates that cubs of this age may survive by themselves as well as cubs accompanied by their mothers. Even the youngest and smallest cubs managed to survive. Three test cubs recovered were among the youngest released (Table 1). One cub weighed only 18 pounds when released, yet weighed 35 pounds when recovered 6 weeks later. Cubs of either sex appeared equally self-reliant (Tables 1, 2). Returns were obtained from 3 of 8 female test cubs, as compared to 4 of 12 males. Both males and females occurred among recoveries of even the youngest cubs.

A significant finding was that physically-handicapped cubs survived almost as well as cubs in good physical condition (Tables 1, 2). Among test animals, there were recoveries for 4 of 8 injured cubs as against 3 of 12 uninjured. Among the controls, two recoveries each resulted from seven injured and five uninjured cubs, respectively.

Test cubs also were able to adjust to unfamiliar environments. All had been removed from the area of their capture. Recoveries resulted from 4 of 9 which were

transferred 35 to 176 miles (average 75), and from 3 of 11 transferred only 4 to 19 miles (average 13).

Thus it appears that black bear cubs of either sex may be self-sufficient when as young as 5½ months and as small as 18 pounds even though almost incapacitated by physical injury and released in unfamiliar range.

ISLAND RELEASES

The Islands

Poverty Island, five miles offshore, is about 320 acres in area and has poor soils and numerous rocky outcrops and bluffs. Its fauna is sparse but includes several mice and the snowshoe hare (*Lepus americanus*). Deer (*Odocoileus virginianus*) are absent. The flora probably is representative of the poor soil portions of the Upper Peninsula mainland before widespread, intensive browsing by deer. Vegetation is predominantly white cedar (*Thuja occidentalis*) and balsam fir (*Abies balsamea*), with striped maple (*Acer pensylvanicum*) and a dense stand of American yew (*Taxus canadensis*) in the understory.

Big Summer Island, 2 miles offshore and about 3 square miles in size, in places has fairly good soil. There are fewer rock outcrops and no high shoreline bluffs. Few mammals occur on the island but deer are present. Unlike Poverty Island, it has little ground cover. Deer have eliminated the yew, severely browsed many deciduous plants, and in many areas killed even balsam fir. The dominant forest is white cedar and balsam fir, except for white birch (*Betula papyrifera*) and sugar maple (*Acer saccharum*), and some beech (*Fagus grandifolia*), quaking aspen (*Populus tremuloides*), and yellow birch (*Betula lutea*) in the center of the island.

On both islands important fruit-producing plants such as strawberries (*Fragaria* sp.), raspberries (*Rubus* sp.), juneberry (*Amelanchier* sp.), and pin and black cherries (*Prunus pensylvanica* and *P. serotina*), utilized heavily by bears on the mainland, are scarce and of poor quality. Because of this, I felt some apprehension over the suitability of the islands for the tests.

The Releases

We released 3 cubs, a 33-pound male about 5¼ months old on July 6, 1956, on Poverty Island, and a male and female, each 32 pounds and about 6½ months old, on August 25, 1956, on Big Summer Island. Shortly thereafter a coyote trapper removed the male of the latter release to the mainland.

In early July, 1957, I revisited the islands and found ample recent sign of both cubs. On July 15, the cub on Poverty Island had to be shot because it was molesting a U.S. Coast Guard dwelling. At that time, it weighed 74 pounds and was in excellent condition.

It is possible that the Poverty Island bear obtained some food from refuse discarded by three guardsmen stationed there part of the year. This could not have been much, and I believe that the guardsmen complied with our request not to feed the animal. There was no human habitation of Big Summer Island. A possible food source on both islands may have been fish and other refuse washed onto the shores, but I saw none at the times of my visits. Numerous gulls frequenting the shores would certainly compete for such food.

The successful establishment of cubs on these islands provides further evidence that cub bears 5½ months of age and older, irrespective of sex, are self-sufficient. A further point of significance is that we had raised both cubs in captivity. They had survived in a habitat judged inferior because of the limited availability of foods commonly considered staples for bears, and despite a lack of previous experience in foraging for food.

SUMMARY

The self-sufficiency of 23 cub bears ranging from 5¼ to 8 months of age was tested in the Upper Peninsula of Michigan. On the mainland, 20 test cubs were released at points remote from their mothers and 12 control cubs were released with their

mothers. Three test cubs were released on Lake Michigan islands devoid of bears.

One third of the cubs released on the mainland were recovered and two cubs released on islands survived the winter. Cubs released alone survived as well as cubs released with their dams. Both sexes survived equally well, and several cubs survived alone despite serious injuries. Black bear cubs of either sex may be self-sufficient when as young as 5½ months and as small as 18 pounds, even though handicapped by physical injury and released on unfamiliar range.

LITERATURE CITED

ALDOUS, SHALER E. 1937. A hibernating black bear with cubs. J. Mammal., 18:466–468.

BURT, WILLIAM H. 1948. The mammals of Michigan. Univ. of Mich. Press, Ann Arbor, Mich. 288pp.

ERICKSON, ALBERT W. 1957. Techniques for live-trapping and handling black bears. Trans. N. Amer. Wildl. Conf., 22:520–543.

MATSON, J. R. 1954. Observations on the dormant phase of a female black bear. J. Mammal., 35:28–35.

SETON, E. T. 1929. Lives of game animals. Vol. 2. Doubleday-Doran and Co., Garden City, New York. 4 v. in 8 fronts. 949pp.

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SEED PRODUCTION BY CURLY-LEAVED PONDWEED AND ITS SIGNIFICANCE TO WATERFOWL

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A review of the literature and examination of herbarium specimens indicates *Potamogeton crispus* L. (plant names: Fernald, 1950) frequently fruits in Europe but seldom does so in North America. However, during the summer of 1958 we observed excellent seed production by curly-leaved pondweed in the Erie Shooting Club marsh. Information gathered as a result of research in that marsh the preceding summer leads us to believe there is an explanation for the unusual fruiting. Further, we believe our observations have significance for possible management of this pondweed as a waterfowl food.

The marsh, located three miles southeast of the town of Erie in Monroe County in southeastern Michigan, is adjacent to Lake Erie, but the part under study is enclosed by a large dike. Water levels within the diked area are manipulated as a management measure by means of a pumping system.

Curly-leaved pondweed, a naturalized species from Europe, has been regarded generally as a "weed" plant on this continent (Martin and Uhler, 1939:129; Pirnie, 1935: 215). Publications dealing with waterfowl foods in North America either do not mention this pondweed as a food item (Cottam, 1939), or state that it is of little or no value as a waterfowl food (Martin, 1951; Martin and Uhler, 1939:129; Pirnie, 1935:215). An important reason for the virtual absence of this plant from lists of North American waterfowl foods is that it seldom bears seed on this continent. The above authors have attested to the lack of fruit. Other persons have mentioned that curly-leaved pondweed is essentially sterile and reproduces mainly by "winter buds" (technically, hibernacula), or other vegetative means (Marie-Victorin, 1935; Moore, 1913; Morong, 1893; Oosting, 1932; Wiegand and Eames, 1925: 49).

All the specimens of this plant in the Herbarium of The University of Michigan were examined. Of 20 specimens collected in Michigan from 1932 through 1954 during June through August, when one would expect flowering and fruiting, 17 were vegetative only, 2 bore flowers, and 1 had mature fruits. Three other Michigan specimens collected at times other than June–August bore no flowers or fruits.

The Herbarium contained one specimen each from New Jersey, New York, and Massachusetts. The New Jersey specimen,

collected in June, 1870, possessed flowers; the Massachusetts specimen, collected in June, 1909, had both flowers and fruits; and the New York specimen, secured in August, 1884, was vegetative only.

Of six European specimens in the Herbarium, three bore only flowers, one possessed only fruits, and two had both. Four were collected in June and the remainder had no date. These specimens suggest that flowering and fruiting is common in Europe. The works of Clos (1856:351) and of Ascherson and Graebner (1907:8 and 23) substantiate the fact that curly-leaved pondweed frequently produces seed in the Old World.

Hunt, who conducted research on the marshes of western Lake Erie for the past 8 years, observed numerous specimens of curly-leaved pondweed in the lower Detroit River during the summers of 1950–1955. The plants were growing in water ranging from 4 to 10 feet in depth in the Detroit River (Hunt, 1957:26, 214, 216, 222). Great numbers of this plant were observed repeatedly in the Pointe Mouillee marsh during the years mentioned above. To the best of our recollection, this species occurred in water 1 to 5 feet deep in the Mouillee marsh. During the summer of 1953 observations were made regarding *P. crispus* in the Erie Club marsh; this pondweed occurred in water 1 to several feet deep. While an occasional specimen of this pondweed was seen flowering, no fruits were observed at any of the above three locations at the times mentioned.

During the summer of 1957 Hunt made an intensive study on the Erie Club marsh. The plant was quite common at that time and a few flowering spikes were noted, but no fruits were found. The plants generally occurred in water depths of 1 to 4 feet with the greater share in 2 feet, or more, of water.

The following year, 1958, water levels were drawn down about 1 foot lower than in 1957. The major part of the curly-leaved pondweed beds were in water 3 to 12 inches deep. Abundant fruiting occurred among the plants in those depths. Few plants were noted and very few fruits developed in depths outside the range just mentioned. No plants of this species were found at depths exceeding 3 feet during 1958. Flowering was first observed June 12, 1958, and maturing fruit was noted on June 23, 1958.

It is our belief that the shallow waters of 1958 stimulated reproductive activity. All of our past experience indicates that deep water is inimical to flowering and fruiting by this species. This contention is supported by Ogden (1943:89) who states that fruits are not usually produced where *P. crispus* grows in deep water, but that it fruits freely in shallow, warm pools.

Since water reduction was commenced during early April and was completed by the latter part of that month in both 1957 and 1958, it is not likely that the timing of drawdown caused fruiting in the second year of study.

Weather conditions during April through June, when initial growth and blossoming occurred, were not greatly different in the 2 years. Precipitation could not be a factor in fruiting because curly-leaved pondweed is an aquatic, and also because the marsh water levels are maintained independently of precipitation. Temperatures were slightly higher (1°F. avg.) during April and May but lower (4°F. avg.) during June in 1958 than in 1957. Temperature was probably not a factor in fruiting and the only effect which we can attribute to temperature is the 9-day earlier blossoming in 1958. The percentage of possible sunshine for April-June, 1958, was somewhat greater than in 1957. A comparison of records from 1950 through 1958 disclosed similar averages and ranges in sunshine data during two other pairs of years in that time for the same months. No fruiting was observed during the 2 years (1952 and 1955) of increased sunshine; thus, it seems to us that the sunshine factor was not important in determining abundant fruiting in 1958 as compared to no fruiting in 1957.

The above weather data are from the U.S. Dept. of Commerce, Toledo, Ohio, records (1950 to 1958). The weather station is about 6 miles from the study area.

Two milacre plots were established in the pondweed beds in order to determine the "standing" crop of seeds. The density of curly-leaved pondweed at the water surface was estimated to be 80 per cent in Plot 1 and 65 per cent in Plot 2. Water depth in both cases was 7 inches.

On July 6, 1958 all *P. crispus* plants were pulled up from each plot and deposited in separate pails. A short time later the seeds were stripped from the heads and put in bottles containing a preservative. Later, the seeds were removed from the fluid and left for 2 hours on paper toweling to permit drainage of excess moisture. Then they were measured volumetrically by water displacement, counted, and weighed on a standard scientific balance.

Four trials served to determine that it took 200.5 seeds (average of 189, 202, 203, and 208) to displace 2 ml. of water. In the case of weight, all seeds from each plot were placed on the balance. On a per acre basis, Plot 1 yielded 56.3 liters, 142.1 pounds, or 5,644,000 seeds; Plot 2 yielded 44.4 liters, 107.5 pounds, or 4,451,000 seeds.

Inasmuch as seeds were collected at only one time, the total production must have been greater than the above data indicate. On the other hand 2 milacres were not an adequate sample of the approximately 260 acres of curly-leaved pondweed.

However, by using the data at hand, one can arrive at an approximation of the number of mallard-sized ducks which an acre of curly-leaved pondweed seed production can support. Mallards and black ducks eat an average of 2.0 to 4.0 ounces per day, according to the information presented by Jordan (1953), Mendall (1949), and Pirnie (1935:145). On the basis of 125 pounds of seed being produced per acre, as an average, then that area would sustain 500 to 1,000 mallard-sized ducks for one day.

Additional observations are pertinent. During the summer the majority of the waterfowl seen in the marsh were present in the areas where *P. crispus* was abundant. Other aquatic plants occurred in those places, too, namely, *Potamogeton pectinatus, P. foliosus,* and *Heteranthera dubia.* These no doubt contributed to the attractiveness of those locations.

However, the value of curly-leaved pondweed as a duck food at the Erie Club marsh is unquestionable. Lutz has been conducting an intensive food habits study there. His collections, made during the summer of 1958 prior to reflooding in September, indicate heavy use of *P. crispus* seeds. Some foliage and winter buds were also ingested. Of 15 dabbling ducks collected during August, 1958, 11 had consumed curly-leaved pondweed seeds. The ducks included five blue-winged teals (*Anas discors*), six mallards (*A. platyrhynchos*), two pintails (*A. acuta*), and two black ducks (*A. rubripes*) (duck names, A. O. U. Check-list, 1957:71, 72, 74, 77). One or more of each of the duck species had eaten *P. crispus* seeds. The 15 ducks had ingested 1,607 seeds of all kinds, of which 267 were curly-leaved pondweed. The 2-foot increase in water depths after early September precluded subsequent use of the seed because the marsh is used almost entirely by dabblers.

We recognize that replication of the conditions which apparently caused excellent fruiting by curly-leaved pondweed is necessary to test the hypothesis that drastic drawdown was the key factor. We intend to attempt duplication and hope that other researchers will have similar opportunities. However, we believe that so significant a production and use of waterfowl food should be reported and suggestions made regarding management.

Therefore, we recommend for those areas where this pondweed is abundant and where water levels can be controlled that drawdown be commenced shortly after the average last date when a killing frost would be expected. Further, water levels should be lowered so that 3 to 12 inches of water remain over the majority of the beds of this pondweed to stimulate greatest seed production. Water depths should be maintained at a stable level throughout the growing season. If management is being practiced to provide food for dabbling ducks, water depths should not be increased following the growing season to a total of

more than 12 to 18 inches in the areas where most seed has been produced, until near time for freezeup. Most dabblers do not feed in water deeper than 18 inches. If the area under management is in a region where winters are severe, 1 to 3 feet more water should be added (total depth: 2 to 4½ feet) as freezeup approaches in order to avoid ice formation to the bottom. Should ice extend to the bottom, damage to plants could result.

We wish to acknowledge the encouragement and financial assistance of the Erie Research Committee and the North American Wildlife Foundation. Our grateful thanks are expressed to Mr. C. E. Kincaid, resident manager of the Erie Shooting Club, and to the generous members of that club who permitted the use of their property and equipment for this study. In addition, we are indebted to Professors W. W. Chase and A. B. Cowan, School of Natural Resources, The University of Michigan, for their review of this article. We appreciate Dr. E. G. Voss' assistance with herbarium specimens and literature.

SUMMARY

An excellent production of curly-leaved pondweed seeds occurred in a marsh at the west end of Lake Erie in 1958. We believe that a reduction in water levels to a depth of 3 to 12 inches caused this excellent reproductive response.

Seeds collected from two milacre plots indicated that one acre would support 500 to 1,000 mallard-sized ducks for one day. A food habits study showed that 11 ducks of 15 collected had used the seeds of this pondweed.

Pending replication of the conditions which we believe caused fruiting, we suggest water level management as follows: (1) draw down in spring to leave 3 to 12 inches of water over *P. crispus* beds, (2) maintain those depths throughout the growing season.

LITERATURE CITED

AMERICAN ORNITHOLOGISTS' UNION. 1957. Checklist of North American birds. 5th edition. Lord Baltimore Press, Baltimore. xiii+691pp.

ASCHERSON, P. AND P. GRAEBNER. 1907. Potamogetonaceae. Das Pflanzenreich, 4, 11. Leipzig. 184pp.

CLOS, M. D. 1856. Mode de propagation particulier au *Potamogeton crispus*, L. Bull. Soc. Bot. de France, 3:350–352.

COTTAM, CLARENCE. 1939. Food habits of North American diving ducks. U.S. Dept. Agric., Tech. Bull. 643. 140pp.

FERNALD, M. L. 1950. Gray's manual of botany. 8th edition. American Book Co., New York. lxiv+1632pp.

HUNT, GEORGE S. 1957. Causes of mortality among waterfowl wintering on the lower Detroit River. Doctoral thesis, U. of Mich., Ann Arbor. x+296pp.

JORDAN, JAMES S. 1953. Consumption of cereal grains by migratory waterfowl. J. Wildl. Mgmt., 17(2):120–123.

MARIE-VICTORIN, FRERE. 1935. Flore Laurentienne. Imprimerie de la Salle, Montreal. 917pp.

MARTIN, ALEXANDER C. 1951. Identifying pondweed seeds eaten by ducks. J. Wildl. Mgmt., 15(3):253–258.

——— AND F. M. UHLER. 1939. Food of game ducks in the United States and Canada. U.S. Dept. Agric., Tech. Bull. 634. 308pp.

MENDALL, HOWARD L. 1949. Food habits in relation to black duck management in Maine. J. Wildl. Mgmt., 13(1):64–101.

MOORE, EMMELINE. 1913. The potamogetons in relation to pond culture. Bull. Bur. Fish., 33: 251–291.

MORONG, THOMAS. 1893. The Naiadaceae of North America. Memoirs of Torrey Bot. Club, 3(2):1–65.

OGDEN, E. C. 1943. Broad-leaved species of *Potamogeton* of North America north of Mexico. Rhodora, 45(531):57–105, (532):119–163, (533):171–214.

OOSTING, HENRY J. 1932. Distribution of the genus *Potamogeton* in Michigan. Mich. Acad. Sci., Arts, & Lett., 15:141–171.

PIRNIE, MILES D. 1935. Michigan waterfowl management. Dept. of Cons., Lansing. xxi+328pp.

U.S. DEPT. OF COMMERCE, WEATHER BUREAU. Climatological data. Ohio Section. 1950: 55 (4):79; (5):103; (6):123. 1951: 56(4):87; (5):115; (6):139. 1952: 57(4):49; (5):65; (6):77. 1953: 58(4):51; (5):67; (6):79. 1954: 59(4):52; (5):67; (6):79. 1955: 60 (4):51; (5):63; (6):75. 1956: 61(4):51; (5):74; (6):82. 1957: 62(4):51, 58; (5):67, 74; (6):81, 87. 1958: 63(4):51, 58; (5):67, 74; (6):81, 87.

WIEGAND, KARL M. AND ARTHUR J. EAMES. 1925. Flora of Cayuga Lake basin, New York. N.Y. Agric. Expt. Sta., Memoir 92. 491pp.

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SOME EFFECTS OF A FIELD APPLICATION OF DIELDRIN ON WILDLIFE

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In the spring of 1954, dieldrin was employed by the Plant Pest Control Branch of the U.S. Department of Agriculture and the Division of Plant Industry of the Illinois Department of Agriculture against a local infestation of Japanese beetles (*Popillia japonica*) near Sheldon, Illinois. Evaluation of the effect of this highly toxic insecticide on wildlife in the area was considered imperative. Continuous, routine field observations were begun on May 3 and continued through August 31, 1954. In the spring of 1955, dieldrin was applied over land bordering the area treated in 1954, and its effect on wildlife was observed whenever possible from April 25 through July 3.

Description of the Area

The treated area in which observations were made includes the town of Sheldon and the farm land immediately eastward from Sheldon to the Illinois-Indiana state line (Fig. 1). The farm land is under intensive cultivation, and the fields tend to be large and symmetrical. Crops are in a corn-soybean-oats-legume rotation. Woody cover is virtually absent in fencerows, and there is very little permanent pasture. The topography is level to gently undulating, and major drainage lines have been ditched.

Application of Dieldrin

The dosage objective for the treated area was 3 pounds of technical dieldrin to the acre. Approximately 1,400 acres were treated in 1954 and 2,600 acres in 1955. The application was accomplished by airplane, except where hand seeders were employed around a few farm buildings and where about 150 acres of cropland were sprayed from the ground in 1955. The application of dieldrin took place April 12 to May 11, 1954 and April 15 to May 6, 1955. While every effort was made to obtain a uniform application, overlapping of treatment occurred, especially on some field borders, and there was some evidence of drift beyond target areas where the insecticide was applied in spray form.

In 1954, the insecticide was applied in two forms. A spray was used on fields scheduled for sowing to soybeans and corn; thus the insecticide was worked into the soil during routine preparation of seed beds. The spray was prepared by adding 50 pounds of technical dieldrin to a petroleum product (TS-28-R) of the Shell Oil Company to make up 50 gallons of spray. Dieldrin in granular form (attapulgus clay granules) was applied to permanent pastures and fields in hay, oats, and wheat. In 1955, the entire area was treated with dieldrin in granular form, excepting about 150 acres which were sprayed from the ground.

Method of Investigation

The precipitous development of the undertaking prevented determination of wildlife composition or population levels prior to treatment. Field observations were designed largely to obtain direct evidence of mortality and to provide data for a comparison of the numbers of warm-blooded vertebrates surviving on treated fields with those on untreated fields. The methods used to evaluate mortality were adjusted as required by the habits of each species studied and are described where appropriate in the section dealing with findings. The area was systematically searched for dead animals, and those which were found before decomposition had advanced too far were collected for study in the laboratory. Much of the wildlife mortality took place within a relatively short time after application of the insecticide, thus placing the observers in the position of being needed everywhere at one time.

During spring and summer of 1954, farmers residing on the treated area were

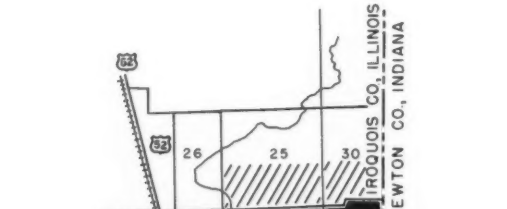

FIG. 1.—The area treated with dieldrin, Sheldon, Illinois.

questioned concerning the effect of dieldrin on wildlife within 2 weeks following treatment. In 1955, farmers residing on land treated in 1954 and 1955 were interviewed systematically during the period of June 27 through July 2. A basis for estimating wildlife losses in Sheldon was obtained by questionnaires distributed to students in biology courses in grade school and high school; the students worked with their parents in listing the number of dead birds and mammals found in the yard of their homes. Returns were received for 52 (13 per cent) of the residences having yards.

FINDINGS

Because mortality is a common occurrence among wild populations of birds and mammals, some question may be raised concerning whether the dead birds and mammals reported here actually died from dieldrin poisoning. Experienced observers recognize that dead birds and mammals in the numbers found on the treated area in such a short time are encountered only under rare and unusual circumstances. For example, on April 29, 1955, inspection of one-fourth mile of osage orange (*Maclura pomifera*) hedge within the area treated on April 22 revealed the following dead animals: one cock pheasant (*Phasianus colchicus*), four brown thrashers (*Toxostoma rufum*), seven robins (*Turdus migratorius*), one meadowlark (*Sturnella*), and one cottontail (*Sylvilagus floridanus*). In addition, two brown thrashers and a hermit thrush (*Hylocichla guttata*) showing symptoms of intoxication were seen. The only living bird noted which appeared healthy was a ruby-crowned kinglet (*Regulus calendula*). The observers immediately inspected a similar hedge one-half mile away in the untreated area. Dead birds or mammals were not seen, and the following living animals were observed in and along the hedge: two pheasants (cock and hen), one brown thrasher, one song sparrow (*Melospiza melodia*), one field sparrow (*Spizella pusilla*), and two woodchucks (*Marmota monax*).

Further, of 22 dead birds and mammals collected in 1954 and suitable for analysis, all except 1 were found to contain some dieldrin upon chemical analysis of their tissues by the Agricultural Chemical Division of the Shell Chemical Corporation. Results of this analysis are presented in Table 1, excepting specimens for which the tissue sample was so small as to cast doubt on the accuracy of the procedure. There was, of course, no basis for certainty that the amount of toxicant found in the tissues showed conclusively that the animal had consumed enough dieldrin to have caused death. The possibility is remote, however, that mortality could have been brought about to any substantial extent in any other manner.

A list of the dead birds and mammals found during inspections of the treated area is presented in Table 2.

Because of the potential influence of the altered insect population on birds and mammals which fed on insects, some background notes were taken on the effect of the poison on insects.

The response of the larvae of Japanese beetles and other Coleoptera to dieldrin

TABLE 1.—ANALYSIS FOR DIELDRIN IN TISSUES OF ANIMALS FOUND DEAD ON THE AREA TREATED WITH THREE POUNDS ACTUAL DIELDRIN PER ACRE NEAR SHELDON, ILLINOIS, IN APRIL AND MAY 1954

Species	Weight of Analytical Sample[1] (grams)	Analytical Sensitivity (p.p.m.)	Toxicant Found (p.p.m.)
BIRDS			
Gallus gallus (2)	28.4[2]	0.2	19.0
Zenaidura macroura	10.6	0.5	< 0.5
Eremophila alpestris praticola	3.2	1.5	11.0
	2.2[3]	2.5	8.3
	3.6	1.5	6.4
Turdus migratorius	5.1	1.0	2.8
Sturnus vulgaris	7.5	0.7	3.3
Passer domesticus	2.4[3]	2.0	8.6
Sturnella magna	5.5	1.0	18.0
Agelaius phoeniceus	4.2	1.5	9.2
MAMMALS			
Blarina brevicauda	2.1	2.5	4.9
Citellus tridecemlineatus	15.7	0.3	17.0
Citellus franklinii	31.3	0.2	36.0
Peromyscus leucopus	2.9	2.0	14.0
Microtus ochrogaster	5.1	1.0	28.0

[1] Samples consist of a composite of brain, kidney, liver, and stomach tissues unless otherwise specified. When present, the stomach contents were included.

[2] Liver tissue only.

[3] Composite of brain, liver, and stomach tissues (including contents, if present).

made the intoxicated larvae especially available to birds and mammals. The Japanese beetle larvae are reported to winter below the frostline and to work upwards as the soil warms in spring. From early May onward they feed just beneath the surface of the ground until they enter the immobile pupal stage. In this instance, however, the intoxicated larvae by the thousands crawled out on the surface where they wriggled vigorously for some time before death. Dead and dying adult insects of many species were abundantly apparent for about 2 weeks following treatment. Few dead insects were seen after the first week in July, and Japanese beetle larvae were not found after mid-June. Birds were observed picking insects off the ground. Although it seemed extremely probable that these insects were intoxicated or carrying poison on their bodies, we have no positive proof that this was the case.

The insect population in the treated area had been strikingly reduced by contrast to insect populations in neighboring untreated fields. For example, grasshoppers appeared to have been eliminated in the treated area, whereas in untreated hayfields a population of 2 to 3 per square foot was evident. By late August, some segments of the insect populations in the treated fields had increased to levels somewhat comparable to those on the surrounding untreated area. Grasshoppers, however, remained obviously scarce in the treated area.

Birds

Game birds.—The treated area was not known to include any part of the covey range of bobwhite quail (*Colinus virginianus*). The only quail mortality known was a single dead bird found by a farmer in a treated field within one-half mile of a covey range immediately following treatment on April 22, 1955.

The Sheldon area is in marginal pheasant range, and pheasant populations are characteristically low with breeding populations averaging 6 to 10 birds per square mile. The breeding population appeared to have been annihilated during the year of treatment. Although the fields were searched almost daily throughout spring and summer in 1954, the only evidence of live pheasants within the treated area was the calling of a cock and some recent tracks seen on two

occasions. Evidence of reproduction was not found in the treated area though broods and nests were found and reported by farmers on surrounding untreated lands. Observers located two dead cocks and a hen, and reports of dead pheasants were received from resident farmers. By spring, 1955, the population seemed to have recovered on the area treated in 1954. Pheasant nests were seen in mowed hayfields, and one brood of seven chicks was seen with a hen. On the area treated in 1955, losses were again severe. Thirteen dead pheasants and two sick cocks were reported by farmers. During limited searching of cropland, largely along drainage ditches, observers found two dead cocks and one dead hen. When interviewed following the first mowing of hay, none of the farmers on the treated area had mowed into hens or nests or seen broods. On June 30 and July 1, 1955, an intensive search of 3 hayfields (16 acres untreated, 20 acres treated in 1954, and 24 acres treated in 1955) which had been recently mowed produced the following results: 1 nest containing 6 eggs and the remains of the hen killed by the mower in the untreated field, 1 nest containing 10 hatched eggs in the area treated in 1954, and no evidence of nesting in the field treated in 1955.

Mourning doves (*Zenaidura macroura*) did not appear to have been adversely affected by dieldrin. The brain, kidney, liver, and stomach tissues of the one dead mourn-

TABLE 2.—LIST OF DEAD BIRDS AND MAMMALS FOUND DURING INSPECTION OF THE AREA TREATED WITH DIELDRIN IN 1954 AND 1955, SHELDON, ILLINOIS

Species	1954	1955	Total
Blue-winged teal, *Anas discors*	1	0	1
Pheasant, *Phasianus colchicus*	3	3	6
Killdeer, *Charadrius vociferus*	0	1	1
Mourning dove, *Zenaidura macroura*	1	0	1
Flicker, *Colaptes auratus*	0	1	1
Horned lark, *Eremophila alpestris*	4	1	5
Catbird, *Dumetella carolinensis*	0	1	1
Brown thrasher, *Toxostoma rufum*	1	7	8
Robin, *Turdus migratorius*	1	21	22
Hermit thrush, *Hylocichla guttata*	0	1	1
Starling, *Sturnus vulgaris*	9	4	13
House sparrow, *Passer domesticus*	0	5	5
Meadowlark, *Sturnella magna*	6	5	11
Redwinged blackbird, *Agelaius phoeniceus*	3	0	3
Common grackle, *Quiscalus quiscula*	0	4	4
Cardinal, *Richmondena cardinalis*	1	0	1
Dickcissel, *Spiza americana*	3	0	3
White-throated sparrow, *Zonotrichia albicollis*	0	2	2
Song sparrow, *Melospiza melodia*	1	0	1
Subtotal	34	56	90
Opossum, *Didelphis marsupialis*	3	1	4
Mole, *Scalopus aquaticus*	0	1	1
Short-tailed shrew, *Blarina brevicauda*	1	0	1
Striped skunk, *Mephitis mephitis*	1	0	1
13-lined ground squirrel, *Citellus tridecemlineatus*	5	0	5
Franklin ground squirrel, *Citellus franklinii*	8	1	9
Meadow mouse, *Microtus ochrogaster*	6	0	6
White-footed mouse, *Peromyscus leucopus*	4	0	4
Muskrat, *Ondatra zibethicus*	4	0	4
House mouse, *Mus musculus*	4	1	5
Cottontail, *Sylvilagus floridanus*	5	14	19
Mice, unidentified	2	0	2
Subtotal	43	18	61

ing dove found during the 2 years were analyzed for dieldrin; the amount found was so small as to cast doubt on whether the bird had received a toxic dose. Mourning doves were observed throughout the summer in Sheldon following treatment, and young doves were known to have been produced. Data on the extent of the productivity of doves, however, were not collected, and there was no basis for determining whether nesting success might have departed from that expected for the area.

Nongame birds.—Nongame birds living and reproducing within the yards of farm homes were affected by the poison, apparently as a result of feeding in surrounding treated fields. In 1954, observations and reports indicated that resident populations of starlings (*Sturnus vulgaris*), robins, and common grackles (*Quiscalus quiscula*) in farmyards within the treated area were sharply reduced during the period May 7-20. In marked contrast, evidence that house sparrows (*Passer domesticus*) in farmyards had been affected by dieldrin was not found. On several occasions in 1954 house sparrows were observed to pick up sick and dead Japanese beetle larvae; however, dead house sparrows were never found or reported, and nesting appeared to be as successful on the treated area as off. Possibly these sparrows, living in or close to farm buildings and taking most of their food from livestock feed, did not come in contact with enough dieldrin to bring about noticeable illness or death. Large numbers of house sparrows inhabiting buildings in stock loading facilities of the Toledo, Peoria, and Western Railroad on the south edge of the treated area were frequently seen in adjacent treated fields, but regular inspection of the building failed to yield dead sparrows or evidence of population reduction.

In 1955, all farmsteads were visited and farmers interviewed on the areas treated in both years, mainly during the period of June 27 through July 2 because personnel and time were limited. Observations and interviews indicated that the pattern of effect of the poison on birds of the farmyards in 1955 was similar to that in 1954 and that bird populations about the farmyards in the area treated in 1954 had returned to normal. Ten of the 13 resident farmers within the area treated in 1955 reported having found dead birds in the farmyard.

In 1955, the west half of the town of Sheldon was treated from the air with dieldrin on April 15 and the east half on April 21. This was particularly hazardous for bird life because of the large numbers of birds attracted by the home landscape. Some birds present at the time, such as the robin and mourning dove, were nesting, and some, such as the hermit thrush and white-throated sparrow (*Zonotrichia albicollis*), were passing through in migration. Data on the effect of the poisoning in this residential area were obtained by intensive observations in a 3-acre yard of one residence on the edge of Sheldon and by random distribution of a questionnaire which produced information on the extent of bird losses at 52 (13 per cent) of the residences.

TABLE 3.—RESULTS OF A QUESTIONNAIRE SURVEY OF BIRD AND MAMMAL MORTALITY IN THE RESIDENTIAL AREA OF SHELDON, ILLINOIS, 1955

Category	Yellow-shafted Flickers	Blue Jays	Brown Thrashers	Robins	Blue-birds	Starlings	House Sparrows	Common Grackles	Cardinals	Fox Squirrels	Rabbits	Totals
Residences reporting:												
Number	1	7	4	42	2	21	18	8	8	10	22	52
Per cent	1.9	13.5	7.7	80.8	3.8	40.4	34.6	15.4	15.4	19.2	42.3	100
Total number reported	1	8	4	128	3	41	49	13	8	13	48	316
Estimated total mortality in Sheldon residential area (375 residences)	7	58	29	923	22	296	353	94	58	94	346	2280

A severe reduction of the bird population took place. Returns from the questionnaire indicated that 1,840 birds were killed (Table 3) in the yards of residences, a total area of about 240 acres. This represented an average loss of about 7.7 birds to the acre. This estimate of losses is believed to be reasonably accurate, for it reflects our findings in the 3-acre yard where 26 dead birds were found, 8.7 per acre during the period covered by the questionnaire (Table 4).

Robins were almost annihilated in Sheldon. In the 3-acre yard, 13 dead robins and 4 recently constructed robin nests without owners were located by April 29. All the 17 dead robins collected in 1955 showed evidence of sexual activity. The brown thrasher also appeared to have suffered heavy losses.

Although house sparrows took more severe losses in town than were evident at farmsteads, 75 per cent were estimated to have survived. Catbirds (*Dumetella carolinensis*) and house wrens (*Troglodytes aedon*) were not known to have arrived in the area in migration until after the dieldrin had been applied. The first catbird was observed on May 3, and a dead catbird was found by observers at the same location on May 21. A report of one dead house wren was verified, and an unverified report of two others was received about a month after the poison had been applied.

The digestive tracts of birds were inspected for food remains whenever possible. Of 36 birds examined, only 4 contained food remains. Large numbers of dead earthworms were found in the area treated on

TABLE 4.—BIRDS OBSERVED IN 3-ACRE YARD AREA OF A RESIDENCE AT EDGE OF SHELDON FOLLOWING APPLICATION OF GRANULAR DIELDRIN ON APRIL 21, 1955

Species	Date of Observation									
	April 26		April 29		May 3		May 17		May 21	
	Dead	Living	Dead	Living	Dead	Living	Dead	Living	Dead	Living
Woodcock, *Philohela minor*						1				
Mourning dove, *Zenaidura macroura*		3		4		4		5		2
Flicker, *Colaptes auratus*		1		1		1				
Red-headed woodpecker, *Melanerpes erythrocephalus*								1		
Barn swallow, *Hirundo rustica*								1		
Purple martin, *Progne subis*						2				
Blue jay, *Cyanocitta cristata*						1				
House wren, *Troglodytes aedon*								1		1
Catbird, *Dumetella carolinensis*						1			1	
Brown thrasher, *Toxostoma rufum*	3	1		2						
Robin, *Turdus migratorius*	9		4	1		1				
Hermit thrush, *Hylocichla guttata*	1									
Ruby-crowned kinglet, *Regulus calendula*		1								
Starling, *Sturnus vulgaris*	1	2	1	5		15		1		
Myrtle warbler, *Dendroica coronata*						2				
Yellow-throated warbler, *Dendroica dominica*						1				
Palm warbler, *Dendroica palmarum*						2				
House sparrow, *Passer domesticus*	3	12		7	1	15		12		8
Redwinged blackbird, *Agelaius phoeniceus*		2								
Baltimore oriole, *Icterus galbula*						1				
Common grackle, *Quiscalus quiscula*	2	5		1		10		3		
Cowbird, *Molothrus ater*						2				
Cardinal, *Richmondena cardinalis*				2		4		2		1
Goldfinch, *Spinus tristis*						5				
White-throated sparrow, *Zonotrichia albicollis*	1			4		8				
Song sparrow, *Melospiza melodia*								1		
Total	20	27	5	27	1	74	0	27	1	12

April 21 following a gentle, 0.8-inch rain on April 24 and 25. It seemed possible that robins might have been poisoned while feeding on intoxicated earthworms. Of nine dead robins collected on April 26, two contained food, but the stomach contents of these robins were composed of insect remains except for three unidentified seeds in one. Earthworm remains were not detected. The other two birds with food remains in the stomach were a meadowlark and a killdeer (*Charadrius vociferus*). Both contained beetle remains, except for parts of a crayfish in the meadowlark.

In that part of the town treated on April 21, birds were seen drinking and bathing in puddles left by the rain which fell on April 24 and 25. It seemed likely that this might have created a special hazard for birds by concentrating the insecticide in the puddles; however, objective data to support the likelihood were not uncovered. The relationship of ground moisture to wildlife mortality caused by insecticides constitutes a subject which should be given close scrutiny.

An effort was also made to evaluate the effect of the poison on bird populations in the cultivated fields of the farm area by collecting data for a comparison of bird populations in treated fields with those of untreated fields. A treated field and an untreated check field were chosen for each major crop (hay, oats, corn, and soybeans). Except for the insecticide treatment, the fields were as similar as the prevailing limitations of choice permitted. Such factors as size, fencerow cover, nearness of farm buildings, and adjoining land use practices were considered. The check areas were located at least one-eighth of a mile from any treated area in an effort to minimize the possibility of drift and "fringe" effect. In 1954, systematic surveys of bird populations in these fields were conducted throughout the spring and summer.

A field was observed for at least 1 hour on each visit unless rain or high winds made it advisable to terminate observations sooner. Observations were conducted in the morning, during early morning if there were no small mammal traps in operation. The data were collected by an observer leisurely walking a zigzag pattern through each field. Because the fields varied in size observations were evaluated on the basis of birds seen per hour. A treated field and its check field were observed on the same morning whenever possible, and on the next trip to these fields the order of time of observation was reversed. Reasonably accurate counts (Table 5) were obtained for the following species: horned larks (*Eremophila alpestris*), bobolinks (*Dolichonyx oryzivorus*), meadowlarks, redwinged blackbirds (*Agelaius phoeniceus*), dickcissels (*Spiza americana*), and grasshopper sparrows (*Ammodramus savannarum*). These data substantiated what appeared obvious to the casual observer; namely, more birds were to be seen in the surrounding untreated fields than in the treated fields. In May and June, during the period of greatest reproductive activity, 1.93 birds per hour were

TABLE 5.—COMPARISON OF THE NUMBER OF SELECTED SPECIES OF BIRDS OBSERVED PER HOUR IN TREATED AND UNTREATED FIELDS IN FOUR TYPES OF MAJOR CROPS IN THE SHELDON AREA, MAY 1–AUGUST 31, 1954

	CORN		SOYBEANS		OATS		HAY	
	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated
Number of hours of observation	26.25	23	31	28.25	43.5	37	43.3	38.5
Number of birds per hour:								
Prairie horned lark	0.91	2.04	0.39	1.03	0.21	0.84	0.09	0.73
Bobolink	0.08	0.0	0.0	0.04	0.12	0.27	0.49	3.92
Meadowlark	0.08	0.13	0.6	0.11	0.32	0.92	0.21	0.81
Redwinged blackbird	0.0	0.04	0.6	0.04	0.07	0.24	0.30	1.79
Dickcissel	0.19	0.35	0.48	0.64	0.32	0.76	1.39	3.35
Grasshopper sparrow	0.04	0.09	0.13	0.18	0.41	1.32	0.76	2.29
Total for all species	1.3	2.7	1.1	2.0	1.5	4.4	3.3	13.4

seen in treated fields as compared to 6.38 birds per hour in untreated fields. The ratio changed but little for the total period of observation, being 1.87 birds per hour in treated fields as compared to 6.27 birds per hour in untreated fields. With the exception of red-winged blackbirds in soybeans, there were more birds in untreated fields than in treated fields. The population differential tended to be more marked in hayfields than in fields of other crops; populations in hayfields were followed in degree by those in oat fields while there was little difference among those in corn and soybean fields.

Further evidence on the effect of the poison on birds in cropland was the failure to observe successful reproduction in any treated fields. Nests, very young birds, adults collecting insects, and family groups were seen repeatedly in untreated habitat. A few nests, some of which contained eggs, were found in treated habitat, but nestlings were never found there. Further, on only two occasions were young birds (other than house sparrows) seen in a treated area, and these were very near untreated fields.

Determination of sex in 35 dead birds of 10 species collected on the Sheldon area in 1955 revealed that 16 were females and 19 were males (Table 6). The sex ratio of the population immediately prior to poisoning was unknown. Inspection of the gonads indicated that all birds for which the sex was determined, except the hermit thrush and white-throated sparrow, were in breeding condition. Of nine robins collected in the 3-acre yard on April 26, five were females. Four active robin nests were known to have been present at the time. However, of 17 robins collected from throughout the treated area, only 6 were females. It should be recalled that robin losses were virtually annihilative.

TABLE 6.—THE SEX OF DEAD BIRDS COLLECTED IN APRIL AND MAY, SHELDON AREA, 1955

Species	Females	Males
Killdeer, *Charadrius vociferus*		1
Flicker, *Colaptes auratus*	1	
Brown thrasher, *Toxostoma rufum*	2	4
Robin, *Turdus migratorius*	6	11
Hermit thrush, *Hylocichla guttata*	1	
Starling, *Sturnus vulgaris*	2	1
House sparrow, *Passer domesticus*	2	
Meadowlark, *Sturnella magna*		1
Common grackle, *Quiscalus quiscula*	2	
White-throated sparrow, *Zonotrichia albicollis*		1
Total	16	19

Mammals

A tabulation of dead mammals located on the treated area in 1954 and 1955 is included in Table 2.

Opossums.—Although the habitat was not particularly attractive to opossums (*Didelphis marsupialis*), three were found dead within the treated area when the cropland was searched intensively in 1954, and one in 1955 when searches were less intensive. Two of the four opossums were found at the edge of a stream.

Moles.—In 1954, an effort was made to evaluate the effect of the insecticide on moles (*Scalopus aquaticus*) by pressing down sections of the ridges of earth over the only mole tunnels which were found, and subsequently examining these places to determine whether the tunnels had been reopened. These limited and crude observations suggested that the moles continued active throughout the summer. In 1955, freshly constructed mole tunnels which were checked prior to treatment on April 15 were considered to be no longer in use when checked again on April 26, and a dead mole was found about 200 yards from this location. The caretaker of the cemetery on the south edge of Sheldon reported that mole tunneling in the cemetery grounds was conspicuous by its absence during spring and summer following treatment on April 22, and a resident of Sheldon who had been having a mole control problem in his yard area reported a similar experience.

Shrews.—Five short-tailed shrews (*Blarina brevicauda*) were taken in 177 trap-nights in two fencerows during May 3–6, 1954, prior to treatment with dieldrin. The cornfields on one side of these fencerows were treated with dieldrin spray on May 6, and the oat field on the other side was

treated on May 10 with dieldrin in granular form. During the period June 3–10, shrews were not taken in 230 trap-nights in these same fencerows. On May 27 a short-tailed shrew was found dead at the edge of a stream about 200 yards east of one of these fencerows. In late summer, August 6 and 7, one short-tailed shrew was caught during 108 trap-nights in the same fencerows. The evidence suggested that the shrew population may have been sharply reduced.

Raccoons.—Evidence of raccoons (*Procyon lotor*) in the form of tracks along the drainage ditches and along the stream running through the treated area was seen regularly. Dead raccoons were not found by observers; however, in 1955, a resident in the treated area reported having seen a sick raccoon which died shortly after being found.

Domestic cats and dogs.—Domestic cats (*Felis catus*) suffered heavy losses. It was estimated that 90 per cent of the cats on farms died following the application of dieldrin in 1954. Fourteen dead cats were reported by the 13 farmers interviewed on the area treated in 1955. In town, three dead cats and three dead dogs were listed among the dead animals reported on the questionnaire.

Striped skunks.—Striped skunks (*Mephitis mephitis*) were not common in the region, and skunk tracks were identified within the treated area on only one occasion during the 2 years. A farmer residing within the area treated in 1955 reported killing a "sick" skunk along a drainage ditch in a field sprayed from the ground on May 5, 1955.

Woodchucks.—The area treated in 1955 included two locations where woodchuck populations were to be found, the high banks along the ditch passing through the western edge of the treated area, and the New York Central Railroad right-of-way which marked the south edge of the treated area. On April 17, prior to the application of dieldrin, 16 of 18 dens on the railroad right-of-way showed evidence of use, and 1 live woodchuck was seen. The west half of the right-of-way was treated with granular dieldrin on April 27 and 28; the east half was sprayed from the ground on May 5 and 6. When the woodchuck dens were checked on May 3, 16 were still in use; however, when they were examined again on May 17, 2 were in use, the use of 2 was questionable, and the remainder were unused. Within the area treated on April 15, 20 of 22 woodchuck dens, along the drainage ditch at the western edge of the area, on April 15 and 16 showed evidence of use; 2 live woodchucks were seen. When again checked on April 26, all dens were unused except one. Dead woodchucks were not found or reported anywhere on the area.

Fox squirrels.—Before treatment, fox squirrels (*Sciurus niger*) were seen only rarely in the agricultural area whereas they were relatively common in the town of Sheldon. Thirteen dead fox squirrels were reported to have been found in the yards of 10 of the 52 residences in Sheldon for which completed questionnaires had been returned. It was estimated from this that 94 fox squirrels may have been killed in the residential area (Table 3). Although fox squirrels had been seen regularly by observers prior to the application of dieldrin, none were seen afterward.

Ground squirrels.—The thirteen-lined ground squirrel (*Citellus tridecemlineatus*) and the Franklin ground squirrel (*Citellus franklinii*) were of common occurrence in the region. The dens of both species were to be found in fencerows with suitable habitat, and dens of the thirteen-lined ground squirrel were found in permanent pastures.

Ground squirrel populations within the treated area suffered what appeared to have been virtually annihilative losses. Although losses were most severe soon after application of the insecticide, some recent sign of ground squirrels continued to be evident until mid-July. During interviews in 1954 and 1955, some farmers expressed satisfaction that the dieldrin had freed their lands of ground squirrels.

In 1954, when the fields were searched intensively, 13 dead ground squirrels (8 Franklin ground squirrels, and 5 thirteen-lined ground squirrels) were found within

TABLE 7.—STATUS OF GROUND SQUIRREL DENS ALONG FENCEROWS WITHIN THE TREATED AREA, 1954

	FENCEROW DESIGNATION					
	FR–E			FR–A AND FR–C		
	May 18	June 16	June 24	May 17	May 24	June 21
DEN STATUS						
Number marked	22			84		
Active		9	0		33	3
Inactive		5	8		44	42
Use questionable		2	2		1	8
Closed		6	12		6	31
Totals	22	22	22	84	84	84

the treated area (Table 2). All of the thirteen-lined ground squirrels were found during the period May 1–15. Dead Franklin ground squirrels were found over a longer period of time.

In 1954, a periodic survey of ground squirrel dens was made in selected fencerows. The status of a den was determined by placing small twigs, straws, or weed stems lightly across the entrance in such a way as to require their removal when animals used the den. Ground squirrels normally removed all of this picket material, sometimes cutting it into pieces or carrying it several feet from the entrance. Pickets thought to have been disturbed by mice were usually opened only at one corner.

Fencerow FR–A, one-fourth mile long, was treated with dieldrin spray for about 100 yards of its length on May 6; the remaining 340 yards was treated with dieldrin spray on May 6 and with granular dieldrin on May 10. Fencerow FR–C, one-half mile long, was treated with granular dieldrin on April 12 and May 20 and with dieldrin spray on April 30 and May 6 at several places along its length. Thus, this fencerow received double treatment on all but about 100 yards of its length. Fencerow FR–E, one-fourth mile long, was treated over approximately one half of its length with dieldren spray on May 1; the remaining half received dieldrin spray on May 1 and granular dieldrin on May 10. At no place were these fencerows closer than one-fourth mile to untreated land.

The subsequent status of ground squirrel dens along these fencerows was checked periodically, and the results of these observations are shown in Table 7. Thus, of 106 dens at which observations were begun in mid-May, only 3 showed evidence of use when examined during the last week of June. A careful examination of these fencerows for marked or unmarked dens during the last week of July failed to reveal ground squirrel activity of any kind. A similar survey, carried out in two fencerows outside the treated area to provide data for purposes of comparison (Table 8), showed that a reduction in den use comparable to that on the treated area did not occur.

TABLE 8.—STATUS OF MARKED GROUND SQUIRREL DENS ALONG FENCEROWS IN AN UNTREATED AREA, 1954

	FENCEROW DESIGNATION						
	FR–I				FR–II		
	May 22	June 16	June 26	June 27	June 16	June 25	June 27
DEN STATUS							
Number marked	49				18		
Active		16	11	18		12	13
Inactive		12	8	9		2	3
Use questionable		9	18	9		4	2
Closed		12	12	13			
Totals	49	49	49	49	18	18	18

A colony of thirteen-lined ground squirrels survived throughout the period of observation in a pasture treated with granular dieldrin on April 12. The dens of the colony extended over an area of about 1 acre along the outer edge of the pasture, which was itself at the outside edge of the treated area. Possibly because of its location, the colony received little dieldrin in consequence of faulty application.

Mice.—The species known to be present on the area were: prairie white-footed mouse (*Peromyscus maniculatus*), northern white-footed mouse (*Peromyscus leucopus*), prairie meadow mouse (*Microtus ochrogaster*), and house mouse (*Mus musculus*).

Sixteen dead mice were found while observations were being made on the treated area in 1954 (Table 2). Of 14 mice found in May, 8 were picked up in the creek passing through the east edge of the treated area. Four were prairie meadow mice; two were prairie white-footed mice; and two were not identified. Though untreated sections of the creek above and below the treated area were inspected regularly, dead mice were never found there. It seemed reasonable to assume that the mice had come to the water following exposure to dieldrin. Dead mice were not found in or near the stream after June 1. Of the two dead mice found after June 1, one was picked up on the edge of a temporary pond on June 3. Two additional white-footed mice were also found near the stream where they had apparently been regurgitated by a red fox (*Vulpes fulva*).

In 1954, mice were live-trapped, marked, and released as a means of obtaining further data on the effect of dieldrin. Immediately upon arrival of the observer in the area on May 3, traps were placed in operation in two fencerows not yet poisoned. The traps were maintained in operation until May 6, when application of the insecticide was begun in adjoining fields. The fencerows, FR–A and FR–B, were each one-fourth mile in length. Cover in the fencerows was primarily bluegrass (*Poa pratensis*), except for an osage orange hedge along about 220 yards of fencerow FR–B. Each fencerow was treated over its entire length with dieldrin spray on May 6; on May 10 all but 100 yards of each fencerow was also treated with granular dieldrin. Thus, unless efforts of those applying the insecticide to cut off the application sharply at the field edges resulted in uneven application, the fencerows may have received a double treatment over 680 yards of their combined length. The nearest untreated field was one-fourth mile from the fencerows. Traps were again placed in op-

TABLE 9.—MOUSE POPULATIONS AS INDICATED BY LIVE TRAPPING IN SELECTED FENCEROWS (FR-A AND FR–B) BEFORE AND AFTER TREATMENT WITH DIELDRIN, SHELDON AREA, 1954

	Peromyscus maniculatus	*Peromyscus leucopus*	*Microtus ochrogaster*	*Mus musculus*	Total
BEFORE TREATMENT					
May 3–6					
Number caught[1]	11	8	1	1	21
Number per trap-night (177 trap-nights)	0.062	0.045	0.006	0.006	0.12
AFTER TREATMENT					
June 3–10					
Number caught[1]	16	9		1	26
Number per trap-night (230 trap-nights)	0.070	0.039		0.004	0.11
August 6–7					
Number caught[1]	18	12		10	40
Number per trap-night (108 trap-nights)	0.167	0.111		0.093	0.37

[1] Repeats from the same trapping period not included.

TABLE 10.—MOUSE POPULATIONS AS INDICATED BY LIVE TRAPPING IN A RED CLOVER HAYFIELD (GD–A) TREATED WITH DIELDRIN GRANULES ON APRIL 12, 1954

	Peromyscus maniculatus	*Microtus ochrogaster*	*Mus musculus*	Totals
May 21–27:				
Number caught	25		2	27
Number per trap-night (290 trap-nights)	0.086		0.007	0.093
June 29–July 9:				
Number caught	23	1		24
Number per trap-night (336 trap-nights)	0.068	0.003		0.071
August 20–24:				
Number caught	13		2	15
Number per trap-night (108 trap-nights)	0.120		0.019	1.139

eration in these fencerows during June 3–10 and August 6–7. The results are tabulated in Table 9.

These data do not indicate that the application of dieldrin resulted in a marked reduction in the mouse population as a whole; however, none of the 15 white-footed mice marked and released during the period prior to application of the insecticide were again trapped during the 7-day trapping period approximately 1 month later. Six of the mice (four white-footed mice, one meadow mouse, and one house mouse) taken during the period prior to treatment died in the traps for some undetermined reason. Although the evidence is far from conclusive, the data suggest that meadow mice were more vulnerable to poisoning than white-footed mice or house mice. Spencer and Spencer (1952, unpublished report) reported that dieldrin ground sprays at 2 pounds per acre gave complete kills of *Microtus*. Although white-footed mice outnumbered meadow mice, perhaps 8 to 1, as indicated in general observations and trapping in untreated fields (Table 10), more dead meadow mice were found in the neighboring treated fields by the observers. Only one meadow mouse was trapped in the treated area following the application of dieldrin (Tables 9, 10, and 11), and this one was caught near the perimeter of the treated area about 7 weeks after application. None was captured in this same field about 6 weeks later, and none was taken at any time after treatment in the fencerows which probably received a double dose over most of their length, even though trapping success had increased for white-footed mice. Five of the 25 white-footed mice taken in June were identified as "young," indicating the success of reproduction. Of the white-footed mice taken in August, five (two prairie white-footed mice and three northern white-footed mice) were recaptured from the June trapping, indicating a survival time of about 2 months for these repeats.

A series of three trapping operations in a clover field to which dieldrin granules had been applied on April 12 did not reveal an important continuing depletion of the mouse population (Table 10). Of the 25 prairie white-footed mice trapped in May, 4 repeated a month later, and 3 repeated two months later, revealing something of the survival time of these mice when exposed to dieldrin granules.

During the period May 12–20, another trapping operation was conducted simultaneously in a red clover field which had been treated with dieldrin granules on April 12 and in an untreated red clover field. It was thought that if the effect of dieldrin granules was most noticeable within the first month after treatment, it might be

TABLE 11.—MOUSE POPULATIONS AS INDICATED BY LIVE TRAPPING MAY 12–20, 1954, IN TWO RED CLOVER HAYFIELDS

	Treated Field[1] (180 trap-nights)	Untreated Field (174 trap-nights)	
	Peromyscus maniculatus	*Peromyscus maniculatus*	*Microtus ochrogaster*
Number caught	12	15	2
Number per trap-night	0.066	0.086	0.012

[1] Treated with dieldrin granules on April 12.

apparent in the results (Table 11). The results did not differ markedly enough to be considered significant; however, more mice were captured in the untreated field, and meadow mice were taken in the untreated field but not in the treated field.

Muskrats.—In 1954, evidence of muskrat (*Ondatra zibethicus*) activity was observed regularly along a stream where it passed through untreated fields above and below the treated area. About 1¼ miles of the stream passed through treated fields. The lower one-fourth mile passed through a pasture treated with dieldrin granules on April 12, the remainder of the treated land through which the stream passed was sprayed with dieldrin on May 5 and 6. During the period May 12–18, three dead muskrats were reported seen in the stream by farmers and four were found by observers. Dead muskrats were not found along the stream above or below the treated portion.

Fresh muskrat signs in the form of droppings, used dens, and tracks were seen within the treated part of the stream until May 6. Evidence of muskrats was not again recorded until a single trail was noted on June 9. Thereafter, evidence of the presence of muskrats in the treated area gradually increased, and on June 26 a den was noted to have been in use.

There were about 4 miles of drainage ditches within the area treated in 1955. About 1½ miles of these were checked for recent muskrat sign on the day the poison was applied and on the following day; 59 focal points of activity were found. A 1.4-inch rain fell on April 19 and 20, causing high water in the ditch and, in effect, flushing it out. The ditch banks were again checked on April 26 after the water had subsided enough to permit an effective search for sign. Recent muskrat tracks were in evidence at only two places, but dead muskrats were not seen. Three dead muskrats, however, were subsequently reported seen along this ditch. Possibly the high water on April 19 and 20 tended to wash the dead and intoxicated muskrats downstream. Muskrat sign was still scarce on this section of the ditch in late summer. It should be noted that 1½ miles of ditch below this stretch also received dieldrin. The remaining 2½ miles of drainage ditch were checked only after the application of dieldrin. Light evidence of muskrat activity was evident, but its meaning was difficult to appraise in the absence of previous knowledge of muskrat activity here. One live muskrat was seen in a section of ditch which had been treated 7 days earlier.

Norway rats.—Norway rats (*Rattus norvegicus*) in the vicinity of farm buildings were not known to have been affected by the insecticide. Rats which remained close to or within the farm buildings and fed on livestock feed were unlikely to have come in contact with the insecticide. Two dead rats were reported within the town of Sheldon, and the observers saw a sick rat on the limb of a willow in the water of the drainage ditch immediately west of Sheldon 11 days after application of the poison.

Cottontails.—In 1954, there had been too little time prior to notification that the area was to be poisoned to permit an appraisal of the cottontail population. Considering the distribution of suitable habitat, however, rabbits could not have been particularly common except around farm buildings and in and around the town. Though repeated searches were made through all likely cover in the treated fields in 1954 subsequent to the application of dieldrin, only one live rabbit was seen, and this one was observed in the northeast corner of the area on May 26 in a pasture treated with dieldrin granules on April 12. Only one farmer reported seeing rabbits during mowing operations in treated fields. In the latter case a young

rabbit was killed by the mower, and another was flushed out of the hay, in a clover field along the south edge of the treated area and adjacent to an untreated field along a railroad track. The field in which the rabbits were seen had been treated with granular dieldrin on April 12. Rabbits were observed in suitable habitat in surrounding untreated fields.

The evidence indicated that a substantial portion of the resident population of rabbits had died within a week after the application of dieldrin. Several farmers reported having seen dead rabbits in the treated fields during the period, May 6–12. These rabbits were not found by observers because exact locations were forgotten, and careful searches of some of the fields indicated that the carcasses had probably been covered by soil in farming operations. There was no reason for doubting the farmers' reports except as to the exact number seen. Reports by individual farmers went as high as "six or seven," only five dead rabbits were recorded by observers (Table 2).

In early spring, 1955, a determined effort was made to locate rabbit concentrations within the area scheduled for treatment and to trap and mark rabbits in these locations. The only places where rabbits could be found in any numbers were along the edge of the town. In 776 trap-nights, 19 rabbits were trapped and tagged during the period March 30 to April 20. Following application of dieldrin, a trapping effort of 210 trap-nights, June 27 to July 3, at locations where the 19 rabbits had been taken during the trapping period March 30 to April 20 resulted in the capture of 2 rabbits, neither of which had been among the 19 previously trapped.

Six of the 19 rabbits were caught and tagged in a 3-acre yard at the edge of Sheldon during the period April 7–20. The yard was within the area treated on April 21. When it was checked on April 26, three dead rabbits were found, one of which was tagged. On five occasions during the month following treatment, this yard was searched intensively for dead and living birds and mammals. An effort was also made to trap rabbits at this location in late June and early July. Live rabbits were not seen, and none were captured during the trapping operation.

Of the three dead rabbits picked up in the 3-acre yard, two were females. Examination of the uterus showed that one female had recently given birth to young; five placental scars of recent origin were present, and the teats were enlarged. The other female contained three embryos ready for birth, one in position for birth with placenta parted. The male was in breeding condition.

The yard of a farm home bordered on the east of the 3-acre yard. When the resident farmer was interviewed on May 17 he reported that he had found several dead rabbits in the yard and that he had taken two sick rabbits away from his dogs during the week following application of the dieldrin. From that time subsequently he had not seen a living rabbit.

Forty-eight dead rabbits were reported at 52 residences in Sheldon following application of dieldrin. It was estimated from this that about 346 rabbits had been poisoned within the residential area of the town, an area of about 240 acres.

Fourteen dead rabbits were found by observers in the agricultural area treated in 1955. All resident farmers within the area treated in 1954 and 1955 were interviewed in late June and early July. They were asked whether they had seen dead rabbits following the treatment in 1955 and about the numbers of living rabbits in evidence at the time of hay-mowing on the area treated in 1954 and 1955. Their replies indicated that adults and young rabbits had been seen during mowing operations in the hayfields treated in 1954 and that rabbit populations had recovered from the poisoning of the previous year. On the area treated in 1955, despite a reluctance on the part of some farmers to admit to having seen dead animals, 7 of 13 resident farmers reported having seen from one to "six or seven" dead rabbits following application of dieldrin. Three of the 13 farmers reported that they had seen young rabbits during hay-mowing.

On April 1, 1957, an effort was made to

TABLE 12.—NIGHTTIME ROADSIDE CENSUS OF RABBITS, SHELDON AREA, APRIL 1, 1957

	Area Treated in 1954	Area Treated in 1955	Area Treated in 1956	Untreated Area
Miles driven	8.2	6.5	2.7	20.4
Rabbits seen	6	11	3	20
Rabbits per mile	0.73	1.69	1.11	0.98

determine whether dieldrin applied in 1954 and 1955 had had a continuing depressing effect on rabbit populations in the treated areas. A roadside spotlight census was conducted along the secondary roads through the treated area. The results (Table 12) indicated that rabbit populations had recovered in the previously treated areas.

DISCUSSION

The application of dieldrin in the Sheldon area was supervised and carried out by professional pest control personnel. The planned dosage was high, 3 pounds of active ingredient per acre. Some wildlife populations took heavy losses; in the case of especially vulnerable species, losses were virtually annihilative. Springer (1956:130) reported that "dieldrin applied experimentally for mosquito control at two-tenths pound per acre in marshes in New Jersey killed some songbirds...." Genelly and Rudd (1956*a*:12–13) believed that dieldrin could be used at a dosage of 0.5 pound per acre without hazard to warm-blooded vertebrates but that acute mortality could be expected at rates of 1 pound per acre and higher. Some of their data (Rudd and Genelly, 1956:87–88), however, cast doubt on whether dosages as low as 0.5 pound per acre are without some hazard. Rudd and Genelly (1956:86) concluded that "Dieldrin is hazardous to fish, bees, game, and domestic animals at crop insect levels of application. This fact is suggested by laboratory experimentation and confirmed by field usage."

Wildlife species show differential vulnerability to poisoning by dieldrin. This seems to result from characteristic behavior and the degree of inherent resistance to the poison. Warm-blooded vertebrates which spend a good deal of time on the ground and include insects in the diet, especially during the season when the poison is applied, are highly vulnerable. Robins, brown thrashers, starlings, meadowlarks, common grackles, and ring-necked pheasants were virtually eliminated within the treated area. All of these species feed on insects to some extent and spend a good deal of time on the ground. Horned larks appeared to suffer heavy losses, but the exact extent was difficult to appraise. These birds also spend much time on the ground, and insects form a substantial part of the diet.

Mourning doves came through with relatively little apparent loss. These birds spend some time on the ground but feed almost entirely on seeds. They also may have greater resistance to poisoning than do other birds. Dahlen and Haugen (1954:479) found that the median lethal dosage, or LD-50, for mourning doves (44–46 mg. per kg.) was almost four times that for quail (12–14 mg. per kg.). Apparently field application of dieldrin to control insects can result in the loss of mourning doves, for Rudd and Genelly (1956:87–88) received reports that "at least 100" mourning doves were killed when an attempt was made to control a rice leaf miner outbreak in California with dieldrin spray at a rate of 0.5 pound per acre.

Few house sparrows were killed around farmsteads, possibly because most of their food was taken from uncontaminated livestock feed. In the town of Sheldon, where uncontaminated food was not readily available, about 25 per cent of the house sparrows were estimated to have been killed by the insecticide.

Ground squirrels, muskrats, and cottontails were virtually eliminated within the treated area. Ryckman, Ames, and Lindt (1953:598) reported that 7 dead ground squirrels and rabbits were recovered 4 days after dieldrin had been applied in spray form

at the rate of 1.4 pounds per acre on an 11.5-acre area. Short-tailed shrews, fox squirrels, woodchucks, and meadow mice seemed to take heavy losses in the Sheldon area, but the extent was not as clearly defined as that for ground squirrels, muskrats, and cottontails. Severe mortality occurred among domestic cats, and some dogs and sheep were killed. White-footed mice were killed; however, they did not appear to be particularly vulnerable to dieldrin poisoning, and their populations appeared well on the way to recovery by late summer.

Most losses took place during the week following application of the poison. About 75 per cent of the dead birds collected by observers were found in the week following exposure to the insecticide. Severe losses to the cottontail and muskrat populations took place almost immediately after the application. While losses to ground squirrel populations were heavy during the week following treatment, virtual elimination of some of the populations under observation required exposure for about 6 weeks.

Observations on symptoms of dieldrin poisoning in wildlife were not extensive. Thirst was the most obvious symptom of intoxicated warm-blooded vertebrates. Many of the dead animals collected on the treated area were found in or at the edge of water.

Symptoms displayed by a poisoned meadowlark when found near death were noted. Although it lacked muscular coordination and could not fly or stand, it continued to beat its wings and clutch with its toes while lying on its side. Its beak was held open, and breathing was labored. Eden (1951:1013) described symptoms of poisoning by dieldrin in 3- and 6-week old domestic chickens as "loss of appetite, extreme nervousness, alternate dilation and contraction of the pupils of the eyes, and spasms." DeWitt (1955:674) found that "Pheasants refused to eat diets containing 0.025 per cent or more of these compounds [dieldrin, aldrin, or endrin], but satisfactory acceptance occurred when the levels were reduced to 0.01 per cent."

Dead ground squirrels exhibited a characteristic attitude in death. The back was bowed, and the forelegs with the toes of the feet tightly clenched were drawn close to the thorax. The hind legs were usually outstretched with the toes of the feet straight and spread wide. The head and neck were outstretched, and the mouth often contained dirt, suggesting that the dying animal had been biting at the ground.

Evidence to the effect that dieldrin brought about a reduction in reproductive capability was not uncovered; however, the circumstances were such that evidence of this kind was not likely to have been found. Perhaps a carefully controlled study of the reproductive effort of mourning doves might have yielded some worthwhile data. DeWitt (1955:674) found that when breeding quail were fed dieldrin at a level of 0.001 per cent of the diet, about a 50 per cent reduction in the hatchability of their eggs occurred and more than 50 per cent of the chicks hatching from eggs of these quail died within 5 days. Genelly and Rudd (1956*b*:538) found that egg production of pheasants fed 25 to 50 p.p.m. of dieldrin was significantly depressed, and egg fertility of birds on a diet containing 50 p.p.m. of dieldrin was significantly lower than that of controls. The lowered hatchability of eggs was believed to have stemmed from poor condition of the hens rather than from dieldrin reaching the embryo. For the first 2 weeks of life, pheasants hatched from the eggs of hens on diets containing 25 or 50 p.p.m. of dieldrin showed significantly greater mortality than did young from the eggs of control hens. From 2 to 8 weeks of age, the young from the test and control hens showed no appreciable difference in survival rates.

In 1954 when dieldrin was applied extensively in two forms, some evidence indicated that dieldrin granules might be less hazardous to warm-blooded vertebrates than dieldrin spray. Dieldrin spray was probably more persistent than granular dieldrin in terms of remaining available at and above ground level. The margin of apparent benefit thus afforded wildlife seemed extremely narrow and subject to question; however, some observations suggested that losses to rabbits, mice, and ground squirrels may

have been less severe in fields treated with dieldrin granules than in fields treated with dieldrin spray. In the case of livestock, the difference was more evident. On April 25, 1954, following light rains totalling about 1 inch on April 15, 16, and 22, 32 sheep and some cattle were turned into a 25-acre pasture which had been treated with dieldrin granules on April 12. The sheep grazed here without apparent ill effect until May 10, when they were driven into a small, untreated bluegrass pasture across a gravel road from a field which had been treated with dieldrin spray on May 6. Evidently some spray had drifted across the road into the pasture, for the sheep began to show symptoms of intoxication almost at once. The sheep remained in this pasture 2 days. They lost interest in food and displayed extreme restlessness, following the pasture fence around and around apparently searching for a way out. Fourteen of the sheep escaped, but, except for two which were never found, they were soon picked up on neighboring farms. The sheep remaining in the pasture refused to be driven, bleated almost continuously, and stood with their heads lowered; they were finally carried from the pasture. The sheep were taken into the original pasture, the one treated with dieldrin granules on April 12. They displayed great desire for water. Two of the sheep were found dead in the stream passing through the pasture, and the remaining sheep were repeatedly driven out of the stream, several having to be dragged forcibly from the water. Three of the sheep eventually died; those remaining recovered to all outward appearances. This pattern of response to dieldrin in granular and spray form was indicated in two other flocks of sheep and a herd of beef cattle.

Other conditions which may have a bearing on the extent of the effect of the poison on wildlife have to do with the method of application and timing with respect to migration. Where an attempt is made to treat different kinds of cropland or crops in the same area with poison in different forms or different dosage levels, the operation extends over a longer period of time, and the overlapping of treatment along the borders of fields becomes more common. Inasmuch as field borders are used frequently by wildlife, the doubling of the dosage resulting from overlapping of applications along field borders would seem to constitute an increased hazard. Dieldrin in granular form was also more suitable to control with respect to accurate placement than dieldrin in spray form. Timing with respect to migration may also merit consideration. In this instance there appeared to have been no loss among warblers and very little among house wrens and catbirds in the treated area, possibly because for the most part they arrived in the area after treatment.

Observations on populations of field-dwelling birds during the summer of 1954 in treated and untreated cropland suggested that the reduction of insect populations within the treated area may have discouraged reoccupation of the treated area by birds. Although horned larks, meadowlarks, bobolinks, red-winged blackbirds, dickcissels, and grasshopper sparrows were seen within the treated area throughout the spring and summer, they showed no evidence of successful reproductive activity there and were seen much less frequently there than in adjacent untreated fields. Eng (1952:336), reporting on the effect on birds of an application of 2 ounces of aldrin per acre, concluded that "A near 100 per cent reduction of the grasshopper population (aldrin) made the area even less desirable for resident pairs and also appeared to affect adversely development of certain nestlings." Birds or mammals largely dependent on fish and crustaceans for food could probably be expected to be affected similarly. Observations on about 2,000 acres of salt marsh in St. Lucie County, Florida, which had been treated with about 1 pound of dieldrin per acre provided evidence (Harrington and Bidlingmayer, 1958:81) that "The fish kill was substantially complete. . . . Mollusks . . . seemed to be unharmed by the dieldrin. Crustaceans were virtually exterminated throughout the area."

This present study indicates that the incidental loss of wildlife during insect control

operations involving the application of dieldrin is likely to be of importance primarily during the year of application even though this insecticide is chemically stable and remains toxic for a substantial period of time. Thus, unless dieldrin is applied on an extremely extensive scale or on an annual basis, its limiting effect on wildlife populations would appear to be largely temporary. Because of the generally high mobility and great recuperative powers of wildlife populations, recovery of most species of wildlife within the year following application would appear probable. The limiting effect of dieldrin on food-animal populations which spend a part of their existence in the soil, such as earthworms and certain insects, however, may extend over a longer period of time and discourage reoccupation of the treated area by birds and mammals feeding on such foods. The use of dieldrin could be disastrous at locations where rare and threatened species of wildlife, especially those with specialized food habits, are concentrated in winter, during migration, or at breeding sites.

RECOMMENDATIONS

Because of the short-term nature of this study, the following recommendations are made in the sense of suggestions, as opposed to hard and fast rules, for the application of dieldrin at levels used in this program.

1. Where dieldrin is to be used in pest control programs, every effort should be made to schedule application for that period of time when the smallest numbers of birds are likely to be exposed.

2. It seems desirable from the standpoint of the welfare of wildlife and livestock to apply dieldrin in a granular form as opposed to spray.

3. The application of dieldrin in successive years in the same area should be avoided because it may constitute a wildlife hazard which may be just as permanent in effect for the period of continued application as a marked alteration of habitat.

4. The use of dieldrin should be avoided in areas where wildlife values take priority over other values.

5. Extensive field use of dieldrin should not be attempted without the supervision of professional entomologists and consultation with representatives of state and federal conservation agencies.

6. Representatives of state and federal conservation agencies should make a special effort to keep informed on the use of dieldrin and other chlorinated hydrocarbon insecticides and to be prepared to advise pest control specialists and the public where situations hazardous to wildlife may be encountered.

7. Research leading to the development of methods for controlling insects without loss to wildlife populations should be encouraged by every possible means.

8. A more concerted effort must be made to obtain knowledge of the effects, especially long-range ones of highly toxic insecticides on wildlife under field conditions. Such studies should be carried out in areas where wildlife populations are at high enough levels to provide significant results and where substantial knowledge of wildlife population characteristics and habitat has been accumulated previous to application.

SUMMARY

A field application of dieldrin, one of the highly toxic chlorinated hydrocarbon insecticides, at a rate of 3 pounds per acre was investigated for its effect on wildlife. Severe losses occurred among wildlife populations despite supervision of the program by professional pest control personnel. Most losses occurred during the week following application. Meadowlarks, robins, brown thrashers, starlings, common grackles, and ring-necked pheasants resident on the area at the time of application were virtually eliminated. Horned lark populations appeared to have taken heavy losses. Bird populations remained depressed in the treated area throughout the spring and early summer, and it was thought that this was to some extent a result of a food shortage in the form of a markedly reduced insect population. Ground squirrels, muskrats, and rabbits were virtually eliminated, and short-tailed shrews, fox squirrels, woodchucks, and

meadow mice appeared to have taken heavy losses. White-footed mice, house sparrows, and mourning doves seemed to exhibit a relatively high resistance to dieldrin poisoning. Wildlife populations appeared to have recovered or to have been well on the way towards recovery by the following year. Recommendations designed to minimize wildlife losses from dieldrin poisoning were suggested.

LITERATURE CITED

DAHLEN, JAMES H., AND ARNOLD O. HAUGEN. 1954. Acute toxicity of certain insecticides to the bobwhite quail and mourning dove. J. Wildl. Mgmt., 18(4):477–481.

DEWITT, JAMES B. 1955. Effects of chlorinated hydrocarbon insecticides upon quail and pheasants. Agric. and Food Chem., 3(8):672–676.

EDEN, W. G. 1951. Toxicity of dieldrin to chickens. J. Econ. Ent., 44(6):1013.

ENG, ROBERT L. 1952. A two-summer study of the effects on bird populations of chlordane bait and aldrin spray as used for grasshopper control. J. Wildl. Mgmt., 16(3):326–337.

GENELLY, RICHARD E., AND ROBERT L. RUDD. 1956*a*. Chronic toxicity of DDT, toxaphene, and dieldrin to ring-necked pheasants. Calif. Fish and Game, 42(1):5–14.

———. 1956*b*. Effects of DDT, toxaphene, and dieldrin on pheasant reproduction. Auk, 73(4):529–539.

HARRINGTON, ROBERT W., JR., AND WILLIAM L. BIDLINGMAYER. 1958. Effects of dieldrin on fishes and invertebrates of a salt marsh. J. Wildl. Mgmt., 22(1):76–82.

RUDD, ROBERT L., AND RICHARD E. GENELLY. 1956. Pesticides: their use and toxicity in relation to wildlife. Calif. Dept. Fish and Game, Game Bull. No. 7. 209pp.

RYCKMAN, RAYMOND E., CHARLES T. AMES, AND CHESTER C. LINDT. 1953. A comparison of aldrin, dieldrin, heptachlor and DDT for control of plague vectors on the California ground squirrel. J. Econ. Ent., 46(4):598–601.

SPENCER, H. J., AND D. A. SPENCER. 1952. Control of *Microtus* in orchards. U.S. Fish and Wildl. Serv., Wildl. Res. Lab., Denver, Colo. Quarterly Rept., July–September, 1952, Proj. 234-CMR25, unpublished.

SPRINGER, PAUL F. 1956. Insecticides—boon or bane? Audubon Mag. 58(3):128–130; 58(4):176–178.

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MIGRATION AND MORTALITY OF HAND-REARED REDHEADS (*AYTHYA AMERICANA*)[1]

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This is the second report concerning migration of ducks hand-reared at the Delta Waterfowl Research Station in southern Manitoba. The first report (Brakhage, 1953) compared migration and mortality of wild and hand-reared ducks of four species for the period 1933–50. The experiments herein reported were conducted (1) to re-evaluate certain findings reported by Brakhage in 1953; (2) to follow the migration and mortality of hand-reared juveniles transported from their natal marsh; and (3) to appraise the value of hand-reared birds in restocking or stocking uninhabited areas. Redheads were used because their eggs were readily available, they are easily reared, and their population levels indicate a need for intensive management.

Many members of the U.S. Fish and Wildlife Service assisted: M. Hammond, K. Krumm and C. J. Henry of the Refuge Branch transported and made observations on hand-reared birds; A. S. Hawkins of the Branch of Wildlife Management banded the wild redheads used for comparison with hand-reared birds and offered many valuable suggestions; A. J. Duvall and Mrs. H. Webster of the Bird Banding Office were most helpful in compilation of band recoveries. We are indebted to G. K. Brakhage, W. H. Elder, M. Hammond, A. S. Hawkins and H. A. Hochbaum for comments on the manuscript.

Eggs were collected from nests of wild birds. Rearing practices were essentially the same as those outlined by Brakhage (1953).

[1] Contribution from the Delta Waterfowl Research Station, the Missouri Cooperative Wildlife Research Unit, and the Department of Zoology and Entomology, Iowa State University.

All birds were held in an outside enclosure at the Delta Station for 2 or 3 weeks prior to release so that they were partially conditioned to the outdoors. They were fed in this enclosure. While still flightless at the age of 5 to 7 weeks they were released either on the Station pond or in the marsh. All hand-reared birds bore a plastic leg band in addition to the U.S. Fish and Wildlife Service band. Plastic bands of a different color were used each year so that sight records could be obtained of homing birds.

RELEASES AT DELTA, MANITOBA

During 1952, 1953, and 1954, 556 redheads were released in the Delta Marsh. Because the low band-recovery rate reported for 1933–1950 by Brakhage (1953) probably was a result of high and unreported local mortality prior to the hunting season, special effort was made during this study to find birds which met with death or injury before they could leave the release area. Seventeen, or 3 per cent, were found dead or injured, or were known not to have migrated, and were not included in the analyses. A maximum of 539 birds was available for shooting. Of these, 123 direct or indirect recoveries (23 per cent) were reported by hunters. Only 6 per cent recovery was realized from redheads previously released in the same area from 1933 to 1950. Reduction in local mortality, improvement of rearing and release techniques, better reporting of bands by hunters due to the presence of the colored plastic bands, all may have increased the percentage of band recovery found during the present study.

FIG. 1. Direct (dots) and indirect (circles) recoveries of wild juvenile redheads banded as flightless young at Delta, Manitoba, 1952 and 1953.

FIG. 2. Direct (dots) and indirect (circles) recoveries of juvenile redheads, hand-reared, banded as flightless young, and released at Delta, Manitoba, 1952–54.

Of 459 flightless wild redheads banded in the Delta Marsh during 1952 and 1953, 26 per cent were recovered by hunters. However, the difference between recovery rates of wild and hand-reared birds was not statistically significant.

Route and Speed of Migration

Recovery data from the present study support Brakhage's (1953) conclusion that there is no difference in migration routes of wild and hand-reared birds (Figs. 1 and 2). An analysis of migration by sexes showed no difference in routes taken by males and females.

Because most hand-reared birds were released on a pond containing captive birds and a source of food, a delay in departure

FIG. 3. Geographic zones used to analyze time of migration (after Brakhage, 1953).

might be expected. Brakhage (1953) analyzed time of travel by comparing average time of recovery of wild and hand-reared birds in certain geographic zones (Fig. 3). His conclusions were weakened by the fact that recoveries of the two groups were made during different years. A similar analysis of direct recoveries of redheads banded in 1953, when both wild and hand-reared cohorts were subject to identical weather conditions, indicates that hand-reared redheads left the Delta area and migrated later than did wild birds (Table 1). Although the samples were small, there were 2 to 9 days' difference in all zones for which four or more recoveries were available.

Homing

Only four records of homing of hand-reared birds were obtained. One female was retrapped at Delta in the spring following release; and two females, identified by their colored bands, were observed on their nests within 100 yards of the point where they had been released the previous year. One female was retrapped during the second fall following its release. No record of homing was obtained for males.

Indirect recoveries of birds shot in the area of release were used by Brakhage (1953) as evidence of homing. He found that 16 to 39 per cent of indirect recoveries

TABLE 1.—AVERAGE DATE OF BAND RECOVERY BY GEOGRAPHIC ZONES[1]

Zone	WILD-TRAPPED		HAND-REARED	
	Avg. Date	No.	Avg. Date	No.
I	Oct. 17	12	Oct. 19	4
II	Oct. 22	14	Oct. 31	10
III (South)	Nov. 14	4	Nov. 20	8
IV (South)	Dec. 2	13	Dec. 6	12
III (East)	Oct. 28	15	Nov. 6	18
IV (East)	Nov. 30	2	Dec. 30	2
Totals		60		54

[1] Based on direct recoveries of redheads banded as flightless birds in 1953 and recovered outside of a 40-mile radius of the release site at Delta, Manitoba.

of hand-reared mallards and pintails were taken in the release area, but no indirect recoveries of redheads were taken in the Delta Marsh in either study.

Mortality

The technique used by Lack (1943) and Hickey (1952) was used to compare mortality of wild and hand-reared birds. Table 2 shows the total recoveries and calculated mortality of wild-trapped redheads; Table 3 shows similar data for hand-reared redheads. Although a few additional recoveries may be expected, they should not alter the conclusions materially. First-year mortality of hand-reared birds was only 1 per cent greater than that of wild birds. A similar comparison for mallards reported by Hickey (1952:68) showed 14 per cent difference and Brakhage (1953) reported 30 per cent, 33 per cent, and 18 per cent differences for mallards, pintails, and redheads, respectively. The influence of extreme vulnerability of young on the direct recovery rate of red-

TABLE 2.—RECOVERIES FROM 478 WILD REDHEADS BANDED IN THE DELTA MARSH, 1952 AND 1953

Year	Number Released	Number Recovered	YEAR OF RECOVERY				
			Direct	Indirect			
			0–1	1–2	2–3	3–4	4–5
1952	86	32	30	0	1	0	1
1953	392	86	70	10	3	3	0
Totals	478	118	100	10	4	3	1
Mortality series (per cent)			85	9	3	3	–
Mortality rate (per cent)*			85	.....	55	.....	

* Mortality rate is the percentage of birds alive at the start of a year which die in that year. Because of the small number of indirect recoveries, a mean figure is presented for adults.

TABLE 3.—RECOVERIES FROM 539 HAND-REARED REDHEADS RELEASED IN THE DELTA MARSH, 1952–54

Year	Number Released	Number Recovered	Year of Recovery				
			Direct	Indirect			
			0–1	1–2	2–3	3–4	4–5
1952	47	4	3	1	0	0	0
1953	390	95	81	7	4	2	1
1954	102	24	22	1	1	0	0
Totals	539	123	106	9	5	2	1
Mortality series (per cent)			86	7	4	2	1
Mortality rate (per cent)			86	.....	.....	58	.....

heads has been discussed by Hickey (1952: 76–77) and must be kept in mind in any consideration of these figures.

Mortality in subsequent years was only slightly higher in hand-reared than in wild birds but samples were small. Hickey (1952: 67) also found adult mortality to be higher among hand-reared than wild mallards in both England and North America. Hand-reared birds apparently remain less fearful of man throughout life.

Local mortality did not differ significantly between wild and hand-reared birds in the present study: 21 per cent and 23 per cent respectively of all recoveries were within a 40-mile radius of Delta. But in 1933–50 Brakhage (1953) reported 68 per cent local recovery of hand-reared redheads and only 27 per cent of wild birds. The decline in local kill may have resulted from two attempted protective measures: (1) a delay of about 2 weeks in the opening of the shooting season established on the Delta marsh in 1947, and (2) a small refuge area established around the village of Delta in 1952. Wild birds reported by Brakhage were banded after establishment of the delayed shooting season, while hand-reared birds had been released before that time. Most of the difference which he observed in local mortality rates between wild and hand-reared ducks may be attributed to this measure. The small refuge also reduced the local kill by protecting those hand-reared birds which lingered at the release site.

Unfortunately, the effectiveness of these two management measures cannot be quantitatively evaluated. Too few local wild redheads were banded prior to the establishment of the delayed local shooting marsh season to compare their mortality rates with birds banded after its establishment. The difference in local kill of wild redheads before and after the establishment of the Delta refuge (27 and 21 per cent, respectively) cannot be attributed to the presence of the refuge because it constituted only a small area of the marsh.

TRANSPORTED REDHEADS

LaCreek Refuge, South Dakota

During August of 1954, 305 hand-reared redheads were moved from Delta to the LaCreek National Wildlife Refuge in south-central South Dakota. This is a small refuge where considerable numbers stop in migration but having few breeding pairs. Hand-reared redheads released at Delta followed the Mississippi and Atlantic Flyways (see Fig. 2), but the 42 direct recoveries of birds released at LaCreek (Fig. 4) show that the majority go directly south to the major Central Flyway wintering area in lower Texas and Mexico.

This conclusion is in agreement with that of Williams and Kalmbach (1943) and Bellrose (1958), i.e., the juveniles removed from their natal marsh prior to the time of their

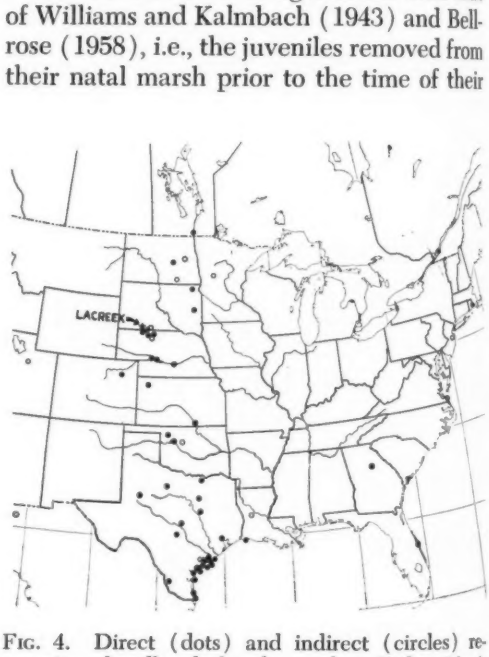

FIG. 4. Direct (dots) and indirect (circles) recoveries of redheads hand-reared at Delta, Manitoba and released at LaCreek National Wildlife Refuge, Martin, South Dakota.

first flight show no innate attachment to that area. The four direct recoveries taken north of the release site cannot be interpreted as a return to the natal marsh. Northward dispersal of young birds is common in many species and is illustrated for wild redheads by recoveries from both Utah (Williams, 1944) and Manitoba bandings (Aldrich, 1949; Brakhage, 1953; and the present study). Direct recoveries in Georgia and Florida of birds released at LaCreek are probably from birds that wandered north in late summer and joined flights moving southeastward along the lake country of Manitoba, Ontario, and the Lake States to the East Coast. It is apparent from Map 4 in Aldrich, (1949) that some ducks banded at Sand Lake in northeastern South Dakota also follow this flight pattern. Such northward movements probably are responsible for the apparent eastward migration of redheads from Utah which Lincoln (1934) reported.

Homing to the area of release was good. Six females were trapped at LaCreek by refuge personnel during the spring following release, but it is not known whether they nested. There was no significant increase in numbers of breeding redheads on the refuge (34 pairs in 1954 and 38–40 pairs in 1955), but presumably some of the females were of Delta stock. No trapping was conducted during subsequent springs.

The indirect recoveries of birds released at LaCreek (Fig. 4) indicated that most birds remained in the South Dakota-Texas flight line in which they first migrated. The fact that several birds were again taken north of LaCreek and on the east coast suggested that post-breeding wandering occurred in these adults and that some may have migrated to other breeding grounds. One record suggestive of this was an indirect recovery of a female taken in Utah.

Seney Refuge, Michigan

The Seney Refuge in the upper peninsula of Michigan has few migrant and no breeding redheads. A release of 177 hand-reared redheads was made in August of 1956. In effect, these birds were placed 650 air miles southeastward of redheads in the Delta area and slightly north of the main eastward flight route. While most of these birds followed the eastward route, there was considerable movement directly south (Fig. 5). Two direct recoveries taken west of the point of release probably represent early juvenile wandering and not a return to the Delta area. At the time of this writing only one indirect recovery (from Michigan) was reported. However, two birds were retrapped in New York and one in Maryland during the spring following release.

In 1957, 100 more redheads were released at Seney. Because some of these birds were recaptured and held over winter, mortality data from this group are not considered. However, 19 direct recoveries plotted in Fig. 5 show that they followed the same flight lanes as in 1956.

C. J. Henry (*in litt.*) reported an increased use of the refuge by migrant redheads fol-

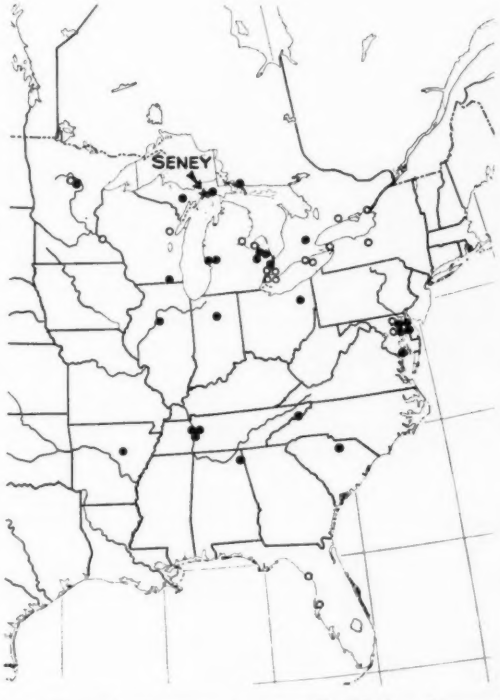

FIG. 5. Direct recoveries of redheads hand-reared at Delta, Manitoba, and released at Seney National Wildlife Refuge, Seney, Michigan. Dots represent recoveries of birds released in 1956; circles represent recoveries of those birds released in 1957.

lowing the releases but found no redheads nesting. The role of hand-reared birds in the increased use of the area is uncertain.

Mortality of Transported Birds

Because of the relatively isolated geographic positions and lower shooting pressure at Seney and LaCreek Refuges than at Delta, the percentage of direct recoveries taken within a 40-mile radius of the release site was also considerably lower. Compared with 23 per cent direct recoveries in the Delta area, 6 per cent were recovered at LaCreek and only 4 per cent at Seney.

Total mortality from LaCreek was also less than from Delta because redheads traveled a shorter distance and faced fewer areas of intense gunning. This is demonstrated by comparing recovery and mortality rates of birds released at Delta with redheads released at LaCreek (Tables 3, 4, and 5).

The direct recovery rate of birds released at Seney (Table 5) indicated that mortality of this group would be considerably higher than at LaCreek and perhaps comparable with Delta despite the low shooting pressure at Seney. Intense shooting pressure elsewhere in Michigan and in the Chesapeake Bay area compensated for low local kill.

DISCUSSION

Data gathered from these experimental releases demonstrated the similarity of ducks hand-reared from eggs of wild birds to ducklings reared in the wild. These birds migrated well and followed routes similar to those of wild birds, but probably departed later and were more vulnerable to gunning. Their behavior more closely resembled that of wild birds than that of any other hand-reared ducks heretofore reported.

TABLE 4.—RECOVERIES FROM 305 HAND-REARED REDHEADS RELEASED AT THE LACREEK NATIONAL WILDLIFE REFUGE, MARTIN, S.D.

Year	Number Released	Number Recovered	Year of Recovery			
			Direct	Indirect		
			0–1	1–2	2–3	3–4
1954	305	55	42	7	5	1
Mortality series (per cent)			76	13	9	2
Mortality rate (per cent)			76		65	

High initial cost per bird and low survival rate restrict widespread use of hand-rearing (Hunt, *et al.*, 1958). Other objections to the use of hand-reared redheads include Brakhage's (1953) warning that "robbing" of nests might influence breeding populations of an area because renesting may not occur in diving ducks. During studies of diving ducks in Manitoba, the senior author obtained two records of renesting from seven canvasback females trapped on the nest. But no renesting records were obtained in Utah and Manitoba from nine incubating redhead females marked before their eggs were removed from their nests. Moreover, the late nesting period of redheads limits the opportunity for renesting.

The above shortcomings would be justified if the young could be used for rapid stocking of uninhabited areas. In spite of the small number of birds released, the results reported here involved a major effort at collection of eggs and rearing of young. The failure of releases at LaCreek and Seney Refuges to improve or establish breeding populations suggests that habitat or shooting pressure are responsible for the small number of breeding birds in these areas. Redheads pioneer new range more slowly than do dabbling ducks (Hochbaum, 1946), but do so when populations are at a normal level. There is little evidence from this or

TABLE 5.—COMPARISON OF RECOVERY RATE AND MORTALITY RATE OF LOCALLY RELEASED AND TRANSPORTED REDHEADS

Releases	Number Released	Direct Recoveries	Direct Recovery Rate (per cent)	First Year Mortality (per cent)
Delta, 1952–54	539	106	20	87
Seney, 1956	177	37	21	*
LaCreek, 1954	305	42	14	78

* Indirect recoveries incomplete.

other studies that artificial stocking speeds the establishment of populations significantly—at least under the conditions of heavy gunning pressure observed in this study.

Further studies must involve still larger groups of birds released in a single area rather than the distribution of small numbers to many areas. A more profitable use of birds reared from eggs collected in the wild would be experimental study of migration, homing, and orientation of ducks. Data obtained in this study add further evidence that the area which serves as "home" during the early flight period is that to which the bird returns. The nature of this attachment and the age at which it develops need to be studied further, for it may well influence migratory behavior and resulting band recoveries from experimental releases of birds of different ages. The influence of climate on migration as discussed by Hochbaum (1956:208), the innate directional sense discussed by Bellrose (1958), pinpoint homing, juvenile wandering in relation to water areas and latitude, and many other facets of juvenile behavior could be studied most conveniently with hand-reared birds of wild strain.

SUMMARY

Juvenile redheads were hand-reared from eggs collected from nests of wild birds. Migratory movements of hand-reared birds were compared with those of wild redheads banded and released in the Delta Marsh during the same years. There were no differences in routes taken by the two groups, but hand-reared birds left the release site later or migrated more slowly, and suffered a slightly higher mortality than did wild birds.

Hand-reared birds were used in an attempt to increase breeding stock of the La-Creek Refuge in South Dakota and to establish breeding redheads at Seney Refuge in Michigan. Although homing of females was good, no increase in breeding redheads resulted from either release.

Ducklings hand-reared from eggs gathered in the wild are useful for experimental studies of migration and other juvenile behavior.

LITERATURE CITED

ALDRICH, J. W. 1949. Migration of some North American waterfowl. U.S. Fish and Wildl. Serv. Spec. Sci. Report (Wildlife), No. 1. 48pp.

BELLROSE, F. C. 1958. The orientation of displaced waterfowl in migration. Wilson Bull., 70:20–40.

BRAKHAGE, G. K. 1953. Migration and mortality of ducks hand-reared and wild-trapped at Delta, Manitoba. J. Wildl. Mgmt., 17:465–477.

HICKEY, J. J. 1952. Survival studies of banded birds. U.S. Fish and Wildl. Serv. Spec. Sci. Report (Wildlife), No. 15. 177pp.

HOCHBAUM, H. A. 1946. Recovery potentials in North American waterfowl. Trans. N. Amer. Wildl. Conf., 11:403–418.

HOCHBAUM, H. A. 1955. Travels and traditions of waterfowl. Minneapolis, Minn.: Univ. of Minn. Press. 301pp.

HUNT, R. A., L. R. JAHN, R. C. HOPKINS, AND G. H. AMELONG. 1958. An evaluation of artificial mallard propagation in Wisconsin. Tech. Wildl. Bull. No. 16, Wisconsin Cons. Dept., Madison. 79pp.

LACK, D. 1943. The age of the blackbird. Brit. Birds, 36:166–175.

LINCOLN, F. C. 1934. Distribution and migration of the redhead. Trans. Amer. Game Conf., 20:280–287.

WILLIAMS, C. S. AND E. R. KALMBACH. 1943. Migration and fate of transported juvenile waterfowl. J. Wildl. Mgmt., 7:163–169.

WILLIAMS, C. S. 1944. Migration of the redhead from the Utah breeding grounds. Auk, 61: 251–259.

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BASAL METABOLISM OF WHITE-TAILED DEER—A PILOT STUDY[1]

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Numerous investigations of the nutritional requirements of deer, and the value of their natural foods, have been undertaken in the interests of habitat improvement or estimation of carrying capacity (Maynard *et al.*, 1935; Forbes *et al.*, 1941; Davenport, 1939; Einarsen, 1946; French *et al.*, 1955; Smith, 1950; Bissell *et al.*, 1955; Bissell and Strong, 1955).

Results of digestion trials on northern white-tailed deer (*Odocoileus virginianus borealis*) conducted over four consecutive years, 1953–1957, by the New Hampshire Fish and Game Department, in cooperation with the University of New Hampshire, differed widely between individuals and groups, presumably because of differences in temperament, physical condition, or degree of tameness (Silver and Colovos, 1957). Basal requirements are characteristic of a species within fairly narrow limits. Total requirements, however, may be greatly modified by numerous internal and external factors including growth, size, body covering, pregnancy, lactation, food consumption, plane of nutrition, activity, fright, and environmental temperature.

Wild animals live under more widely varying conditions than domestic stock; it is seldom possible to secure adequate consumption of food; the emotional impact of capture, confinement and handling is unpredictable, and often violent and disastrous. Normal existence may or may not impose equal stresses, but these are certainly not the same, nor comparable to, those associated with feeding trials. In the case of large wild animals, the value of nutrition balances is questionable unless supported by data on basal metabolism.

Basal metabolic rate, or basal metabolism, is the heat production of a resting animal in a thermally neutral environment and in the postabsorptive state without any stimulating effect of food. Considerable work has been done by Benedict (1938) and Brody (1945) on comparison of the metabolism of different species. The work of neither, however, included a study of the metabolic rate of deer. In fact, very few wild animals have been studied because it is difficult to make measurements under the prerequisite physical conditions. The principal difficulty encountered is, naturally, in inducing the animals to relax.

Information on basal metabolism is fully as important as knowledge of local environmental factors in estimating carrying capacity. Without adequate data, estimates of feed requirements are subject to grave error. Assumptions of increased consumption needed to combat severe weather are, too often, vague and theoretical, and based on data derived from species which differ widely in basal metabolic rate, body conformation, composition and covering, food habits and behavior.

The authors know of no data on basal metabolism of deer, and it was to supply this deficiency that the present study was undertaken. Experiments have been limited by available funds, and the time which could be devoted to them at the Animal Nutrition Laboratory of the University, which is primarily concerned with nutrition of domestic species. The investigation, which continues, may not be completed for several years. Because of the scarcity of information on the subject and its impor-

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For assistance in carrying out this study, acknowledgment is due to the Fish and Game Commission, Director Ralph G. Carpenter, 2nd, and Hilbert R. Siegler, New Hampshire Fish and Game Department; Professors Joseph Seiberlich and Laurance E. Webber, Engineering Experiment Station, University of New Hampshire; and Director H. A. Keener, Agricultural Experiment Station, University of New Hampshire.

tance to sensible herd management, results of the first year's work are presented at this time, since, without research of this type, progress in management cannot occur with any consistency.

TECHNIQUES

In February and June, 1958, basal metabolic rate of four white-tailed deer was measured. To minimize the effect of growth or age, the measurements were made on adults in the prime of life. Two bucks and two does, between the ages of 1½ and 2 years, were chosen. All had participated in the 1957 digestion trials. They were unusually tame and had been trained almost from birth to accept intimate handling, and alternate freedom and close confinement, as a part of everyday existence.

Before the start of the tests the metabolism equipment was set up in the pen to permit the deer to become accustomed to it. They were rewarded with apples for voluntarily entering the crate. When they showed no fear of it they were shut in for some part of each day, and, a little later, the metal shell of the chamber was placed over the crate. At times they were thus confined for a day or two, with fans and pump operating. Duration of this training period was determined by individual behavior, and measurements were not made until each animal would lie quietly in the chamber without display of nervousness. The greatest length of time required to attain this state of composure under test conditions was, for the already very tame deer used in the experiments, 20 days.

The animals were unusually relaxed, with much less movement than might be expected. Ritzman and Benedict (1938), in reporting comparable experiments with cattle, note that "large ruminants . . . become less alert as fasting progresses, even to the point where they exhibit a measure of indifference after the stimulating effect of food has ceased."

A 2,430-liter respiration chamber, used in the Animal Nutrition Laboratory of the University for measurements on calves and other domestic animals of similar size, was used for the deer. This equipment and its principles of operation have been described by Ritzman and Colovos (1943).

Standard procedure used in this laboratory for domestic animals was followed. Two measurements were made for each animal, one at 30–35 hours, and one at 50–55 hours after feed. Fasting periods were spent in the chamber, so that each deer had been acclimated for at least 30 hours immediately prior to the tests.

The two runs were made on consecutive days, each lasting a total of 8 hours. The animals were under constant supervision, with all changes of position and time spent standing, recorded. Measurements were adjusted to the basis of 24 hours spent lying. (See Ritzman and Benedict, pp. 100–101, for discussion of correction factors in use at the University of New Hampshire for energy expended in standing.)

Chamber temperatures ranged from –7° to 2.9° C. for February, and from 19.2° to 24.7° in June. The low chamber temperatures during the February tests were a matter of necessity. The deer pen was unheated and there was no means of raising the temperature within the chamber. Nor were there facilities for simultaneous recording of body temperatures while the deer were in the sealed chamber.

FINDINGS

In the case of the ruminant, a respiratory quotient approaching 0.7, the fat quotient, and the absence of methane are criteria that the postabsorptive state has been reached. The respiratory quotients were nearly the same (.70–.74), methane was absent, and heat production was practically identical at both levels, indicating that the postabsorptive state had been reached for both the measurements taken 30–35 hours after feed, and those made 50–55 hours after feed.

Many workers in the field of energy metabolism are of the opinion that basal metabolism in adult warm-blooded animals, generally speaking, is proportional to body surface, or the 0.73 power of the weight. (There are many exceptions, as pointed out by Benedict (1938), and more work should

TABLE 1.—BASAL METABOLISM OF FOUR WHITE-TAILED DEER

	Doe No. 1	Doe No. 2	Buck No. 1	Buck No. 2	Avg.
Weight (kg.)	51.80	40.00	61.80	51.14	51.19
Chamber temp. (C.):					
Range 1st run	–3.0°— –4.0°	19.2°—24.7°	–1.8°—2.9°	20.9°—22.2°	
2nd run	–2.0°— –7.0°	20.3°—21.9°	–2.1°—0.2°	19.6°—22.0°	
Avg.	–3.9°	21.5°	–0.4°	21.2°	
RQ 1st run	.73	.74	.73	.73	
2nd run	.72	.72	.72	.70	
Coat	Winter	Summer	Winter	Summer	
Heat prod./24 hrs. (cal.):					
As measured	1,272	1,160	1,534	1,327	1,323
Per kg.	24.6	29.0	24.8	25.9	26.1
Per sq. m. body sur.	936	991	1,003	962	973
$W^{0.73}$	46.0	50.7	48.9	48.5	48.5

be done before these generalizations are accepted.) Comparison of heat production on the basis of $W^{0.73}$ is more generally favored since few animals have been actually measured, and body surface is ordinarily calculated by $S = 10 \times W^{2/3}$.

Heat production of the four deer, as measured, and proportional to both surface area and $W^{0.73}$ is shown in Table 1. The latter value was calculated according to the formula used by Benedict (1938:177) where

$$W^{0.73} = 10^3 \left[\frac{\left(\frac{\text{Tot. heat prod. per 24 hrs.}}{\text{Wgt. in g.}^{0.73}} \right)}{10} \right].$$

Brody (1945:372) should also be consulted on derivation and use of this method.

Doe No. 2 had a higher metabolism in the June measurement than Buck No. 2, measured at the same time, and higher than Doe No. 1, whose metabolic rate was measured in February. Unfortunately, both does were pregnant, and this difference in metabolic rates may have been due to the more advanced pregnancy of Doe No. 2.

Doe No. 1 was pregnant 102 days at the date of her measurement, and gave birth to twins on May 26, during the 16th week following the measurement. Doe No. 2 was pregnant 148 days, and bore a single fawn on July 16, in the sixth week after her tests. Total weight for both births was the same, 8.5 lbs. at 2 days of age.

Table 2 compares the basal metabolism of deer, as measured in these tests, with that of goats, sheep, and cattle, as reported by Benedict (1938).

Results for all four animals were in close agreement, and the metabolic rate was not higher at temperatures below 0°C. than at temperatures in the vicinity of 20°C. (ordinarily chosen for such tests since temperatures around 20°C. are within the zone of thermal neutrality for most species).

There was a remarkable agreement between these direct measurements and the estimated basal metabolism of mule deer used by Bissell *et al.* (1955), which was calculated from Brody's formula (1945).

DISCUSSION AND RECOMMENDATIONS

The limits of the zone of thermal neutrality for deer are not known, and it is important to establish the lower limit, or critical temperature (at which metabolism is increased to combat cold). That the metabolic rate of the deer was not higher in February than in June suggests that the critical

TABLE 2.—BASAL METABOLISM OF DEER COMPARED TO THAT OF GOAT, SHEEP AND CATTLE

	Goat (doe)	Sheep	Deer	Cow and Steer
Weight (kg.)	36.0	45.0	51.2	500
Heat prod./24 hrs. (*calories*)				
As measured	800	1,160	1,323	6,200
Per kg.	22.2	25.8	26.1	12.4
Per sq. m. body sur.	734	917	973	1,094
$W^{0.73}$	37.8	46.5	48.5	42.9

temperature for fasting deer, in winter coat, may be below 0°C., and, since fasting raises the critical temperature, still lower for well-fed animals. This is considerably below the critical temperature for domestic species, although Benedict (1938:59) states that 11°C. is not outside the zone of thermal neutrality for sheep.

If the low February chamber temperatures were within the range of thermal neutrality, as they appear to have been, results were not adversely affected by this enforced departure from customary procedure.

It seems likely that the change from summer to winter coat (doubtless in combination with less obvious factors such as blood volume change, change of vascularity relative to depth of tissue, and fat deposits) compensates for environmental temperature within the range encountered.

Further investigation is needed to substantiate or contradict these tentative conclusions; it can not be too strongly emphasized that figures based on so small a sample should not be accepted as authoritative. If sufficient measurements can be made to establish limits of confidence for the basal metabolic rate, it should be possible to measure the separate effects of most factors which increase metabolism, and to use this knowledge in combination with local data on populations, age-composition, sex-ratios, weather, food species and utilization, to greatly facilitate management.

Particular attention should be given to differences in metabolism attributable to sex; the relative importance of stage of pregnancy and individual difference in the higher rate measured for Doe No. 2 can not be determined. Brody's findings (1945) on the effects of pregnancy on domestic species are probably not applicable to wild animals, particularly deer, which are subject to "normal winter loss" during half to two-thirds of the gestation period. Bred does on this project have not been noticeably less active than other deer, all of which reduce their activity in winter. Unbred does should be measured, and the metabolism of late pregnancy, lactation, rut, and growth needs to be studied.

The effect of tranquilizers should be measured. If it can be demonstrated that any of these are without effect on metabolism, their use would greatly simplify handling of deer for laboratory work.

In conjunction with reliable data on basal metabolism, a respiration chamber in which temperature, light intensity, air velocity, and humidity could be varied to simulate any desired combination of weather conditions should provide much needed information on winter starvation. The "Climoactometer," built by the Pennsylvania Game Commission (Gerstell, 1938), was designed to study the effect of climate on game, and incorporated facilities for measuring heat production. The California Department of Fish and Game has recently constructed similar equipment (personal communication, Harold D. Bissell, February 17, 1959).

The similarity between the basal metabolism of sheep and deer, as shown in Table 2, suggests the possibility of substituting sheep (which are cheaper to raise, more readily obtained and easier to manage) for deer in digestion trials. While the normal foods of sheep, under farm management, are quite dissimilar to those of deer, sheep are efficient browsers. Such a substitution should not be undertaken without comparative digestion trials, and careful consideration of intraspecific differences in reaction to all factors affecting metabolism. California studies of comparative digestibility of browse by deer and sheep (Bissell and Weir, 1957) seem to indicate that differences between species are not greater than individual differences observed in deer. Further investigation was recommended.

SUMMARY

Basal metabolism of four white-tailed deer was measured in February at –1.2°C. (avg.), and in June at 22.3°C. (avg.). Heat production was not higher in February, suggesting that change of coat and other factors compensate for the lower temperatures of winter, and that the critical temperature for fasting deer in winter coat is below 0°C.

Results for all animals were in close agree-

nancy, had a rate slightly higher than the other doe or either of the bucks. Average values obtained were similar to those of sheep.

Investigation of effects of age, sex, activity, and environmental factors is recommended. Use of a respiration chamber with variable temperature, light intensity, air velocity, and humidity is suggested.

LITERATURE CITED

BENEDICT, FRANCIS G. 1938. Vital energetics. Carnegie Inst. Washington. 215pp.

BISSELL, HAROLD D., BRUCE HARRIS, HELEN STRONG, AND FRANK JAMES. 1955. The digestibility of certain natural and artificial foods eaten by deer in California. Calif. Fish and Game, 41(1):57–78.

——— AND HELEN STRONG. 1955. The crude protein variations in the browse diet of California deer. Calif. Fish and Game, 41(2): 145–155.

——— AND WM. C. WEIR. 1957. The digestibilities of interior live oak and chamise by deer and sheep. Jour. Animal Sci., 16(2):476–480.

BRODY, SAMUEL. 1945. Bioenergetics and growth. Reinhold Pub. Corp., New York. 1,023pp.

DAVENPORT, L. A. 1939. Results of deer feeding experiments at Cusino, Michigan. Trans. N. Amer. Wildl. Conf., 4:268–274.

EINARSEN, A. S. 1946. Crude protein determination of deer food as an applied management technique. Trans. N. Amer. Wildl. Conf., 11:309–312.

FORBES, E. B., L. F. MARCY, A. LEROY VORIS AND C. E. FRENCH. 1941. The digestive capacities of the white-tailed deer. Jour. Wildl. Mgmt., 5(1):108–114.

FRENCH, C. E., L. C. MCEWEN, N. D. MAGRUDER, R. H. INGRAM AND R. W. SWIFT. 1955. Nutritional requirements of white-tailed deer growth and antler development. Pa. State Univ., Agric. Exp. Sta. Bull. 600. 50pp.

MAYNARD, L. A., GARDINER BUMP, ROBERT DARROW AND J. C. WOODWARD. 1935. Food preferences and requirements of the white-tailed deer in New York State. N.Y. State Cons. Dept. and N.Y. State Col. Agric. Bull. 1. 35pp.

RITZMAN, ERNEST G. AND FRANCIS G. BENEDICT. 1938. Nutritional physiology of the adult ruminant. Carnegie Inst. Washington. 200 pp.

——— AND N. F. COLOVOS. 1943. Physiological requirements and utilization of protein and energy by growing dairy cattle. Univ. of N.H. Tech. Bull. 80. 59pp.

SILVER, HELENETTE AND N. F. COLOVOS. 1957. Nutritive evaluation of some forage rations of deer. N.H. Fish and Game Dept., Tech. Cir. 15. 56pp.

SMITH, ARTHUR D. 1950. Feeding deer on browse species during winter. Jour. Range Mgmt., 3(2):130–132.

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MOURNING DOVE PRODUCTION IN FOUR IDAHO ORCHARDS AND SOME POSSIBLE IMPLICATIONS

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The mourning dove (*Zenaidura macroura*) is common in southeastern Idaho from late April to mid-September or early October, nesting during most of that period in a wide variety of habitats. The present study was undertaken in 1953 to obtain information on breeding densities and reproductive success in orchards. To the best of my knowledge, no prior attempt had been made to measure the productivity of a dove population in the Northwest.

Some of the data from this study are compared with information from other states. This paper also examines the problem of standardizing reports on productivity and explores some implications suggested by the information available with special reference to management of the mourning dove in the future.

THE STUDY AREAS

The field work was conducted in four old orchards located from 4 to 5 miles southwest of the town of American Falls in Power County, Idaho. The Kramer orchard is about 1½ miles south of the Snake River and is surrounded by non-irrigated wheatlands; the other three (Dille, Nash, and Schultz) are somewhat nearer the river and surrounded by or at the edge of irrigated

lands. The orchards contain mostly apple trees (*Malus* spp.), with pear (*Pyrus* sp.), plum and cherry trees (*Prunus* spp.) present in lesser numbers. Boxelder (*Acer negundo*), ash (*Fraxinus* sp.), Lombardy poplar (*Populus nigra* var. *italica*), cottonwoods (*Populus* spp.), junipers (*Juniperus* spp.) and big sagebrush (*Artemisia tridentata*) variously border or invade the fruit orchards. A total of 527 living trees was present in 1953.

The Kramer and Nash study areas were heavily grazed in 1953, the other two ungrazed. The Schultz orchard was occasionally irrigated and the growth of grasses and forbs was heavy. Downy brome (*Bromus tectorum*) dominated the herbaceous vegetation in the Dille orchard. Three of the orchards appeared to have had horticultural care some years prior to 1953, but all four were being given little attention at the time of this study.

METHODS

Observations began on June 11. Although nesting had been in progress for 3 or 4 weeks, observations made during mid-June indicated that results of the season's first round of nesting were reliably observed. I visited the orchards at intervals ranging from 1 to 13 days. All known nests were examined and all trees searched for new nests on each visit. No nests were found on the ground; two were found in sagebrush within one of the orchards. Trees were not climbed for the purpose of examining nests. Most of the dove nests were looked into by means of a mirror on an extendible pole. When possible, the status of nestlings was determined with 8-power glasses. Visits to nests ranged from 2 to 9 per nest and averaged 5.4 per nest. Nestlings were not banded because the attendant disturbances were not considered compatible with an attempt to determine production values.

In keeping with a previously employed criterion (McClure, 1942; Randall, 1955), the greatest number of active nests found on a single day in each orchard was considered as indicative of the "approximate nesting population" (pairs) for that orchard. Lowe (1956) has suggested that estimates of the number of breeding pairs based on the maximum number of active nests are probably low because "it is not likely that all pairs will have a nest active at any one time." Cowan (1952), thinking that some breeding pairs "may be missed," corrected for this error which he "estimated at approximately 14 per cent." I made no attempt to correct for a likelihood with an estimate for which I observed no basis.

A "nesting attempt" was considered established by (1) the presence of an adult on a nest, or (2) the deposition of at least one egg in a nest even though an adult was never seen on the nest and the apparent attempt failed to produce young. A nesting attempt was considered "successful" if it produced either one or two doves to fledgling age as ascertained either by direct observation or by the appearance of the nest evidencing occupancy by young to the fledgling stage. Exceptions to the success criteria were a pair of nestlings about one-fourth grown and a pair about one-third grown, at the time of the last nest check, which were projected as successful nestings.

THE NESTING SEASON

Reports from cooperators show that in both 1952 and 1953 migrating mourning doves reached southeastern Idaho during the latter half of April, but that the full complement of the breeding population had not arrived until early May. Observations in 1952 showed that the earliest incubation began during the first week of May, while some pairs delayed building their first nest of the summer until the last week of May, possibly even later.

In 1953 the peak of nesting activity for the 4 orchards as a whole occurred during the latter two-thirds of July; 92 active nests were found during the period of July 11 to 15 inclusive, and again from July 22 to 27 inclusive. The greatest number of nests concurrently active in one of the orchards was found, however, in mid-June. The orchards were last visited on August 26 and 27 when 16 active nests were found. It was estimated that the last fledglings to leave the nest would do so about September 6.

The essential data gathered are summarized in Table 1.

PRODUCTIVITY

The breeding season of the mourning dove in southeastern Idaho allows three complete nesting cycles although it is not known what percentage of the breeding pairs undertake three nestings. While the successful fledging of broods of three doves has been reported (Dodson, 1955:38; Nice, 1922), no more than two doves were fledged by a given nesting attempt in the Idaho orchards. Maximum natality (Odum, 1959: 160) of the four breeding populations reported here might, therefore, be calculated to have been 600 fledglings (100 pairs × 3 attempts × 2 fledglings). However, this potential was not attained inasmuch as only 510 eggs were laid and 324 young fledged (Table 1). Natality in this instance may be expressed as 54 per cent of the theoretical maximum production, or as 64 per cent of the attempted production (eggs laid).

Expressed as a young-old ratio, 1.62 doves were fledged per breeding adult. If one discounts mortality among flying doves as well as migrational departures or arrivals and the probable presence of non-breeding adults, juvenile doves would have furnished about 62 per cent of the fall population.

Whether or not these findings reflect mourning dove production throughout the Northwest is unknown. Observations at many sites on the Snake River Plain lead me to believe that a considerable proportion of the breeding population there nests on the ground. Recent studies in northwestern Oklahoma, where trees are also scarce, have shown that "ground nesting is apparently somewhat less successful than tree nesting," but that, in terms of total production for the region, "tree nesting is less important than ground nesting" (Downing, 1959). The same may be true for much of the Intermountain West.

TABLE 1.—MOURNING DOVE PRODUCTION IN FOUR ORCHARDS AND THEIR IMMEDIATE ENVIRONS, POWER COUNTY, IDAHO, 1953

Total acreage of the orchards	13.4
Pairs of breeding doves (approx.)	100
Nests found	208
Nesting attempts	266
Successful nesting attempts	177
Clutches	263
Eggs laid	510
Eggs hatched	385
Young fledged	324

LIMITING FACTORS

Causes of losses among both eggs and nestlings were largely obscure. Wind, reported as an important limiting factor in other regions, appeared to be negligible in the orchards studied. Wind velocities, as recorded by the U.S. Weather Bureau Station at the Pocatello Municipal Airport about 24 miles northeast of the study areas, showed monthly averages ranging from 10.5 m.p.h. in June to 8.8 in August, 1953. The maximum velocity (61) during the period of study was recorded on May 21; maximum velocities for each of the four months following were 37, 34, 35, and 43, respectively.

No recognizable evidence of mammalian predation on doves was found. Damage to dove eggs by other birds was seen on three occasions. Magpies (*Pica pica hudsonia*) were commonly seen and heard in and about the orchards but appeared to be exerting little or no pressure on dove nests.

At no time in three seasons (1952 through 1954) of observing nestlings and banding flying doves have symptoms of trichomoniasis been detected.

While 61 (16 per cent) of the doves that hatched failed to fledge, only 11 were found dead; 9 of these were in nests, the other two on the ground below a nest. No evidence indicating the fate of any of the other 50 was observed. The 11 dead nestlings seen varied from newly hatched to approximately 7 days of age at time of death. It may be that all nestlings found dead in the nest were the victims of parental absence.

DISCUSSION

On standardization.—Lack of standardization in gathering and presenting data on the nesting of mourning doves has been pointed out as preventing "direct compar-

ison of results in terms of either the breeding population or production" (Southeastern Assn., 1957:30). Perhaps standardization has been retarded by the tendency to report productivity in several ways, viz., fledglings (1) per acre, (2) per breeding pair, (3) per nesting attempt, (4) per successful nesting, (5) per active nest, and (6) per hundred eggs laid. Nesting success, not a production value in terms of fledglings, has frequently been emphasized.

Some confusion may have resulted from the failure to distinguish precisely between a "nest" and a "nesting," terms the denotations of which are clear and well established. The dove's habit of reusing a nest during a given breeding season would itself seem to demand that the term "nest" be restricted to the structure in which as many as six clutches (Cowan, 1952:513) may be laid. Each act of using that nest in an attempt to produce young should be distinguished as a "nesting" or a "renesting," as the case may be, or simply as a "nesting attempt."

The lack of standardization in reporting production per unit area has been attributed to the "many types of habitat involved" and differences in "the selection of study areas" (Southeastern Assn., 1957:30). These conditions no doubt express the well-known distribution of breeding mourning doves through many biotic communities. Call counts in southeastern Idaho (1952 to 1956 inclusive) have revealed the presence of doves during the breeding season in sagebrush-grass, juniper, mixed shrub, aspen, Douglas fir, and aspen-fir types, and in both dry farming and irrigated areas associated with these native vegetational types. Nests of mourning doves have been found on the ground in the overgrazed sazebrush-grass type of the Snake River Plain and in the sagebrush-grass-juniper complex of foothills slopes. In addition to using the trees of farmyards and orchards, mourning doves nest in native junipers, sagebrush and Douglas fir (*Pseudotsuga taxifolia*).

One of the manifestations of adaptability that appears often to have influenced choice of study areas is the clumping tendency of breeding doves. Many of the production studies have been made in relatively small "islands" of concentrated nesting. The high nesting success and productivity that often characterize these colonies can be determined readily because of the circumscribed pattern of the habitat. While the lack of standardization of data may in part stem from the wide differences in nesting densities throughout the country, a comparison of production values per acre in several such breeding situations that are more or less similar in nature may be instructive (Table 2).

Management of the mourning dove is generally considered to be "primarily the control of the hunting harvest" (Edminster, 1954:449). The need for a measurement of production to assist in formulating hunting regulations (Southeastern Assn., 1957) is obvious. Productivity data immediately useful to management are those which indicate population structure and trend in terms of numbers annually available for harvest. The unit of reproductive success basic to the manipulation of hunting seasons and bag limits is, therefore, the number of young fledged per breeding pair, especially if convertible to total population estimates.

TABLE 2.—MOURNING DOVE PRODUCTION IN SOME BREEDING SITUATIONS ENTIRELY OR LARGELY ORCHARD

State	Year	Nesting Habitat		Fledged Per Acre	Reference
		Kind	Acres		
Oklahoma	1950	Orchard	5.	70.0	Dodson (1950)
Oklahoma	1951	Orchard	5.	47.0	Dodson (1951)
Oklahoma	1952	Orchard	5.	77.6	Dodson (1952)
Colorado	1952	Pear orchard	4.5	77.5	Figge, *et al.* (1953)
Utah	1952	Orchard and grove	2.	30.5	Dahlgren (1955)
Idaho	1953	Four orchards	13.4	24.2	(This study)

TABLE 3.—YOUNG FLEDGED PER BREEDING PAIR OF MOURNING DOVES

State	Year	Fledged Per Pair	Reference
Texas	1950	6.7	Swank (1955)
California	1948–50	6.2	Cowan (1952)
Iowa	1938–39	5.3	McClure (1942)
North Dakota	1952	4.6[1]	Randall (1955)
North Dakota	1952	4.4[2]	Randall (1955)
Pennsylvania	1954	4.0	Howarth (1954)
Utah	1951–52	3.9	Dahlgren (1955)
Colorado	1952	3.4	Figge, *et al.* (1953)
North Dakota	1950	3.2	Boldt and Hendrickson (1952)
Idaho	1953	3.2	(This study)
Georgia	1950–51	2.1	Hopkins and Odum (1953)
Georgia	1954	2.0	Lowe (1956)

[1] In natural cover in a small coulee.
[2] In a shelterbelt.

Production per pair has been measured by several widely scattered studies (Table 3). For the purpose of comparing reproductive success in the several localities, simultaneously gathered data would be ideal. Excepting McClure's study in Iowa (1942), these investigations were conducted at various times during the 7-year period ending in 1954. Despite whatever chronological spread the studies suffer, consideration of their findings, including comparison, may be instructive.

Austin (1951) has computed from band recoveries, most of which came from hunters, that at least 4.6 young per pair must be produced to maintain the dove population. The Southeastern Assn. (1957:29) states that "indications from study areas are that doves in general . . . produce 5.1 young per pair." If obvious complacency toward matters of increasing the population (Russell, 1954) is fostered by such estimates, the following may be noteworthy. Of the 12 production ratios compiled in Table 3, 8 fall below the 4.6 suggested by Austin as the minimal reproductive performance for assuring at least a stable population. The average of these 12 published ratios is 4.1 young per pair, 20 per cent less than the value reported by the Southeastern Association.

While measurement of production per nesting pair serves the needs of those charged with regulating the take of mourning doves, it does not provide a standard for comparison of the basic reproductive performance throughout the country. Doves show geographic differences in the average number of nestings attempted per breeding season; for example, 4.8 attempts in California (Cowan, 1952), 4.4 in Texas (Swank, 1950), 2.7 in Idaho, 2.3 in North Dakota (Boldt and Hendrickson, 1952), and 2.2 in Georgia (Hopkins and Odum, 1953). The nesting pair is, therefore, not the unit upon which to base direct comparisons of dove production. Rather, the nesting attempt and the egg (in effect, the attempted fledgling), as units of reproductive effort, are the bases for standard expressions of breeding success (Table 4). Which unit of effort will allow

TABLE 4.—COMPARISON OF SOME SUCCESS VALUES FOR BREEDING MOURNING DOVES

State	Year	Fledged		Per Cent of Nestings Successful	Reference
		Per Nesting Attempt	Per 100 Eggs Laid		
North Dakota	1952	1.38	69.4	71.1	Randall (1955)
California	1948–50	1.28	70.3	66.3	Cowan (1952)
Idaho	1953	1.21	63.5	66.5	(This study)
Louisiana	1950	1.16	*	65.5	Newsom (1951)
Iowa	1955	1.08	55.5	61.1	Jumber, *et al.* (1956)
California	1944, 1946–49	1.03	52.3	55.2	McClure (1950)
Iowa	1938–40	0.87	46.7	47.9	McClure (1942, 1950)
Nebraska	1941–43	0.85	44.5	47.0	McClure (1946, 1950)

* Data not available.

the more accurate measurement of production is yet to be determined. It may be that simply because the egg is the "lowest common denominator" of the readily observed aspects of dove production, success is best expressed as fledglings per hundred eggs laid. Furthermore, both nesting attempts and eggs can be counted with greater accuracy than can breeding pairs.

Production per successful nesting attempt has frequently been reported. However, this value seems to adhere rather closely to a constant (1.78 to 1.87) in six of the eight studies on which Table 4 is based) that functions more or less independently of breeding conditions. If so, it is meaningless as a comparative measurement of success. For example, an identical number of fledglings (1.83) was produced per successful nesting at Lewis, Iowa, from 1938 to 1940 (McClure, 1950) and again in 1955 (Jumber, *et al.*, 1956), and near American Falls, Idaho, in 1953. Yet, in 1955, doves at Lewis, Iowa, fledged 24 per cent more per nesting attempt and 19 per cent more per 100 eggs laid than during the earlier study; in the Idaho orchards, production per nesting attempt and per 100 eggs exceeded McClure's findings in these categories by 39 and 36 per cent respectively. Furthermore, of the two studies reporting the highest and nearly the same values for these two categories (Table 4), one reports the highest production per successful nesting, and the other the lowest in this group of eight studies, namely, 1.94 in California (Cowan, 1952) and 1.59 in North Dakota (Randall, 1955).

Nesting success, expressed as per cent of nestings successful, appears in many reports on mourning dove productivity. Dodson (1955:42) felt that, in some situations at least, this value "does not necessarily reflect the production as such." Nesting success does, indeed, show little relation to production per breeding pair. For example, a nesting success of 66.3 per cent in California resulted in the production of 6.2 fledglings per pair (Cowan, 1952), whereas essentially the same nesting success (66.5 per cent) reported here produced only 3.2 young per nesting pair. While these variants no doubt reflect latitudinal differences in number of nesting cycles per breeding season, discrepancies also inhere in the practice of considering a nesting attempt "successful" if it brings off either one or two young.

However, nesting success cannot be dismissed as meaningless regarding production. Although the data in Table 4 are limited, they clearly suggest a correlation between the percentage of nestings successful and numbers fledged (1) per nesting attempt and (2) per 100 eggs laid. Further investigation may prove nesting success useful as an indicator of production in terms of these basic units of breeding effort, especially under circumstances where information more detailed than nesting success cannot be gathered as readily. I suggest that all three of these values are of further importance in that they reflect the effectiveness of breeding habitat. When Dodson (1955:42), working in Oklahoma, computed nesting success in shelterbelts at about 15 per cent as compared with about 52 per cent in a "protected" orchard, he had found expression of the comparative effectiveness of two arboreal habitats in terms of mourning dove production.

Breeding habitat.—Especially interesting is the possibility "that dove production is density-dependent," i.e., that mourning doves "may be stimulated to nest more frequently and successfully when nearby pairs are present" (Hopkins and Odum, 1953). Data from the four orchards reported on here only hint at such density-dependent responses (Table 5).

It is conceivable that higher nesting densities and their greater reproductive achievements have no cause-and-effect relationship, but that they are the coincident effects of better breeding situations. In other words, it may be that the better breeding habitats not only attract and permit higher nesting densities but that they are primarily, if not solely, responsible for higher nesting success and natality. If, indeed, the proximity of neighbors does stimulate breeding, it should be remembered that the phenomenon of proximity is itself a corollary of kind of habitat. The degree of proximity (i.e., den-

TABLE 5.—SOME MOURNING DOVE PRODUCTION VALUES RELATIVE TO NESTING DENSITY IN FOUR ORCHARDS, POWER COUNTY, IDAHO, 1953

Orchard	Nesting Density (Doves per Acre)	Nesting Attempts per Pair	Per Cent of Nestings Successful	Production		
				Per Acre	Per Pair	Per Nesting Attempt
Dille	1.1	2.5	79.8	41.7	3.7	1.5
Nash	0.7	2.6	63.8	21.9	3.2	1.0
Kramer	0.6	2.8	54.8	17.5	2.8	1.0
Schultz	0.5	2.8	61.1	14.8	2.9	1.0

sity) may, in turn, be a function of condition of habitat.

There is evidence that the mourning dove will respond quickly to changes in the condition of breeding habitat. Within a year or so after this production study was made, the Dille orchard was damaged by undetermined causes resulting in a considerable loss of foliage. On June 11, 1956, Elwood Bizeau and I visited this orchard to band nestling doves. Many if not most of the fruit trees had dead tops. We found six active nests, whereas, during the period June 11 to 17, 1953, at least 29 nests were active here. Nearby road construction caused the removal of a few trees sometime later, and on July 26, 1958, approximately 13 per cent of the original 164 living trees were gone and 28 per cent were standing dead. Some recovery, mostly in the form of adventitious growth about the lower limbs, was apparent among the apple trees with dead tops. I found 17 active nests in this orchard where 5 years earlier on July 24 I had found 39.

The Kramer orchard, having suffered no such damage and having lost only 8 per cent of its original 166 living trees by the summer of 1958, serves as a control in an unintentional experiment. During the period June 11 to 17, 1953, active nests numbered 25 in the Kramer orchard; 38 were found on June 11, 1956. On July 27, 1953, 23 active nests were found here, 28 on the same date in 1958. The obvious increases in the number of active nests in the relatively little altered habitat support the suggestion that the marked decreases (56–79 per cent) in nesting density in the damaged orchard give evidence of response by mourning doves to condition of the habitat. It seems to follow that improvement of breeding habitat (in the Intermountain West, at least) could be expected to increase nesting density if not the number of nesting attempts and production per pair.

However, seemingly excellent nesting habitat may not always result in high breeding density. Elwood Bizeau informs me (letter, June 16, 1958) that, while many fruit orchards in eastern Idaho present apparently desirable nesting situations, he knows of "no nesting concentrations anywhere near approaching" those near American Falls. At the extreme, in two orchards near Pocatello and approximately 30 miles east-northeast of the American Falls sites, I found no dove nests in June, 1953, although doves were in the immediate vicinities. The Pocatello orchards are on the floors of narrow foothill valleys where the absence of adjacent wheat fields and the presence of juniper forest on near-by steep slopes make the environs quite different from those of the orchards near American Falls. These circumstances suggest (1) that nesting cover may not necessarily be the exclusive factor in maintaining a high breeding density, and (2) that the immediate environs of nesting habitat may materially influence its use by mourning doves.

Russell (1954) has written that the problem of mourning dove management "lies not in matters of increasing the population but in wisely utilizing the new crop produced each year." There is, at the same time, increasing concern among game management agencies about our expanding human population and the consequent increase in demands upon harvestable wildlife resources. That concern might well be translated into investigation of ways to augment productivity before problems emerge. Kinds of trees

TABLE 6.—PERCENTAGE OF LOSSES DURING INCUBATION AND BROODING PERIODS OF THE MOURNING DOVE

State	Year	PER CENT LOST		Reference
		Eggs	Nestlings	
North Dakota	1952	26.6	5.1	Randall (1955)
California	1948–50	22.1	9.8	Cowan (1952)
Idaho	1953	24.5	15.8	(This study)
Utah	1951–52	24.0	18.2	Dahlgren (1955)
Colorado	1952	30.6	18.9	Figge, *et al.* (1953)
California	1944, 1946–49	32.9	22.0	McClure (1950)
Iowa	1938–40	45.4	14.6	McClure (1950)
Nebraska	1941–43	46.4	17.0	McClure (1950)
Average		31.6	15.2	

that could be planted to increase the annual production of doves has, for example, been considered in Oklahoma (Dodson, 1955:40). Continued disregard for research on the relationship of habitat to dove production is indefensible.

Of long-range significance to game managers are those data which reveal "weak links" in the reproductive sequence of a harvestable species and thereby suggest possible approaches to assessing and improving the breeding situation. A comparison of the number of dove eggs lost with the number of nestlings lost might be helpful in this connection. Since the incubation and brooding phases last about the same length of time, the number lost in each phase can be treated as a rate and the two rates compared. McClure (1942) reported that "four times as many eggs as young were lost." However, this comparison does not recognize that the number of nestlings available to decimating factors is considerably less than the number of eggs subject to loss. The comparative effects of environmental resistance upon these two developmental stages might, therefore, be quantified more accurately by expressing egg loss as a percentage of the initial number of eggs and nestling loss as a percentage of the initial number of nestlings.

Four of 8 studies disclose the percentage of eggs lost being more than twice that of nestlings (Table 6). If one assumes that factors of security remain essentially constant during a given nesting cycle, these data indicate marked phasic differences in vulnerability to limiting factors. McClure (1942) attributed the "greater success of young doves" to "increased diligence on the part of the parents in protecting the nest," the tendency of the nestlings to "cling to the nest material," and the increasing weight of nestlings adding to the stability of the nest. For purposes of research the hypothesis that nesting habitats offer less security to dove eggs than to nestlings might be useful.

However, such an ecological relationship need not be accepted as inevitable for the mourning dove in the light of habitat manipulation. If efforts to increase the production of mourning doves ever receive attention, analysis of nesting data, with reference to both the causes of failure (disregarding infertility of eggs) and the factors of security as they relate to each phase of the nesting process, might help economize the evaluation of breeding habitats.

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SUMMARY

Mourning doves nest in a variety of habitats in southeastern Idaho where the breeding season allows three nesting cycles. In 4 orchards totaling 13.4 acres near American Falls, Power County, approximately 100 pairs attempted 266 nestings in 208 nests in 1953; 67 per cent of the nestings were successful. Of 510 eggs laid, 385 hatched; 324 fledglings comprised 64 per cent of attempted production. Causes of mortality were obscure.

The nesting attempt and the egg, as units of reproductive effort, are basic to standard expressions of breeding success. Nesting success shows some correlation with numbers fledged per nesting attempt and per 100 eggs laid.

While dove production may be density-dependent it should be remembered that proximity is a corollary of kind of habitat, and that degree of proximity (density) may be a function of condition of habitat. Improvement of preferred breeding habitat may permit an increase in nesting density, but the immediate environs of such habitat may influence its use by mourning doves. Since losses of eggs exceed those of nestlings by about 2:1, any attempt to improve breeding habitat might benefit by an evaluation of security factors as they respectively relate to the incubation and brooding phases of the nesting process.

REFERENCES CITED

AUSTIN, O. L., JR. 1951. The mourning dove on Cape Cod. Bird-Banding, 22(4):149–174.

BOLDT, W. AND G. O. HENDRICKSON. 1952. Mourning dove production in North Dakota shelterbelts, 1950. J. Wildl. Mgmt., 16(2): 187–190.

COWAN, J. B. 1952. Life history and productivity of a population of western mourning doves in California. Calif. Fish and Game, 38(4):505–521.

DAHLGREN, R. B. 1955. Factors affecting mourning dove populations in Utah. Master's thesis, Utah State University, Logan. 93pp.

DODSON, M. 1950. Migratory bird study. Annual Report, Project 32-R-1, Okla. Game and Fish Dept. 27pp. (mimeo.)

———. 1951. Migratory bird study. Annual Report, Project 32-R-2, Okla. Game and Fish Dept. 29pp. (mimeo.)

———. 1952. Migratory bird study. Annual Report, Project 32-R-3, Okla. Game and Fish Dept. 35pp. (mimeo.)

———. [1955] Oklahoma migratory game bird study. Report for 1949–1953 under P-R W-32-R, Okla. Game and Fish Dept. 51pp.

DOWNING, R. L. 1959. Significance of ground nesting by mourning doves in northwestern Oklahoma. J. Wildl. Mgmt., 23(1):117–118.

EDMINISTER, F. C. 1954. The mourning dove. Chap. 14, American game birds of field and forest. Charles Scribner's Sons, N.Y. 490pp.

FIGGE, H. J., G. I. CRAWFORD, H. M. SWOPE, W. W. SANDFORT, D. E. OWENS AND H. M. BOEKER. 1953. Game bird surveys: Mourning dove study. Colorado P-R Project W-37-R-6. Pittman-Robertson Quarterly, 13(3):242. (Cited by permission.)

HOPKINS, M. N. AND E. P. ODUM. 1953. Some aspects of the population ecology of breeding mourning doves in Georgia. J. Wildl. Mgmt., 17(2):132–143.

HOWARTH, R. C. 1954. A study of the mourning dove in Centre County, Pennsylvania. Unpub. master's thesis, Penn. State Univ., Univ. Park. 45pp.

JUMBER, J. F., E. L. KOZICKY AND D. L. CARTER. 1956. Factors influencing mourning dove production at Lewis, Iowa, 1955. Iowa Bird Life, 26(3):59–61.

LOWE, J. I. 1956. Breeding density and productivity of mourning doves on a county-wide basis in Georgia. J. Wildl. Mgmt., 20(4): 428–433.

MCCLURE, H. E. 1942. Mourning dove production in southwestern Iowa. Auk, 59(1):64–75.

———. 1946. Mourning doves in Nebraska and the west. Auk, 63(1):24–42.

———. 1950. An eleven year summary of mourning dove observations in the west. Trans. 15th N.A. Wildl. Conf., pp. 335–346.

NEWSOM, J. D. 1950. Mourning dove study. P-R Quart. Prog. Rpt., Project 15-R-2, July–Sept., 1950. La. Wild Life and Fisheries Comm. 10pp. (mimeo.)

NICE, M. M. 1922. A study of the nesting of mourning doves. Auk, 39:457–474.

ODUM, E. P. 1959. Fundamentals of Ecology. W. B. Saunders Co., Philadelphia and London. 546pp.

RANDALL, R. N. 1955. Mourning dove production in south central North Dakota. J. Wildl. Mgmt., 19(1):157–159.

RUSSELL, D. M. 1954. Mourning dove investigations in Kentucky; a four year progress report. Ky. Dept. of Fish and Wildl. Resources. 90pp. (processed).

SOUTHEASTERN ASSOCIATION OF GAME AND FISH COMMISSIONERS. 1957. Mourning dove investigations 1948–1956. Published by Southeast. Assn. of Game and Fish Comms. Printed at Columbia, S.C. 166pp.

SWANK, W. G. 1955. Nesting and production of the mourning dove in Texas. Ecology, 36(3): 495–505.

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BRIEFER ARTICLES

OBSERVATIONS ON SPAWNING OF BURBOT IN LAKE SIMCOE, ONTARIO

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Literature in the life history of the burbot (*Lota lota lacustris*) (Speirs, 1952) is limited to only a few papers, none of which provides adequate data on the spawning of the species. The purpose of this paper is to present observations on the time, place, and other facts related to the production of burbot in Lake Simcoe. Lake Simcoe is the fourth largest of Ontario's inland lakes with an area of 280 sq. miles, and supports substantial populations of burbot, lake trout, whitefish, cisco, and other cold water fishes (McCrimmon, 1956).

METHODS

The experimental netting of burbot outlined in this paper was done with hoop nets set beneath the ice of Lake Simcoe and tributary rivers during January, February, and March between 1949 and 1958 by management personnel of the Ontario Department of Lands and Forests. Local winter anglers were of assistance in determining the movements and concentrations of burbot in the lake. Age determinations were done by the otolith method (McCrimmon and Devitt, 1954).

OBSERVATIONS

The studies of 1954 and 1955 were concerned with the winter movement of burbot into tributary rivers of Lake Simcoe to determine the time, duration, extent, and purpose of these winter runs. While sampling was carried out in one or two rivers in subsequent years, attention was focused in 1956 and 1957 on the winter movements and spawning activity of burbot in the open lake.

Studies on burbot moving up the larger tributary rivers of Lake Simcoe during the winter of 1954 (McCrimmon and Devitt, 1954) and subsequent years showed this movement to be primarily a feeding run with the numbers of burbot increasing greatly in the immediate postspawning period rather than a spawning run as had been believed previously and as reported for other waters (Mackay, 1957). Observations on the stream runs of burbot from 1955 to 1958 confirm but add little biological data to that reported by McCrimmon and Devitt (1954), and the reader is referred to this paper for a discussion of the movement, growth, and food of the burbot. The numbers of burbot taken by experimental winter netting in the larger rivers during the years of study are presented in Table 1. These winter runs, more extensive in some rivers than others, represent only a minority of the lake population of burbot.

Because of the absence of major spawning runs in the tributary rivers of Lake Simcoe, efforts were made in 1955 to find spawning areas in the open lake. A spawning run was located on Nolan's Shoal, and it was there that observations were made during the winters of 1956 and 1957.

Nolan's Shoal is a long narrow shoal extending nearly halfway from the shore towards Georgina Island, the largest of Lake Simcoe's islands lying about two miles off shore. On account of its geographic location between the mainland and the island, a continuous gentle current of water passes over the shoal. This current is the only apparent feature which distinguishes Nolan's Shoal from

TABLE 1.—CATCHES OF BURBOT FROM EXPERIMENTAL WINTER NETTING IN TRIBUTARY RIVERS OF LAKE SIMCOE DURING JANUARY, FEBRUARY, AND MARCH

Year	Name	Number	Total Harvest for Year
1954	Talbot River	967	
	Sutton River	799	
	Atherley Narrows	676	2,813
	Pefferlaw River	349	
	Whitefish River	15	
	Jersey River	7	
1955	Talbot River	470	
	Sutton River	517	1,680
	Pefferlaw River	622	
	Whitefish River	71	
1956	Talbot River	491	491
1957	Talbot River	419	419
1958	Talbot River	118	220
	Holland River	102	
Total			5,623

similar shoals where burbot do not congregate for spawning. The current prevents the formation of safe ice except under extremely cold weather conditions, and winter observations on the shoal were limited to periods when the ice was safe.

The shoal lies at a depth of 3–15 feet over a greater part of its length. The bottom is covered by sand, gravel, smooth rubble, and stones. The stones are generally imbedded in the sand or silt. The gentle current seems to keep the surface of the gravel and stones relatively free of sediment. Spawning was observed to take place largely on the deeper areas of the shoal. It was seldom observed in water less than 5 feet deep.

During the years of study, the mature burbot were observed to congregate on the shoal during mid-January. By the 23rd of the month, when experimental nets were installed, burbot were abundant but had not begun to spawn. Spawning activity came on rather suddenly near the end of January and was practically completed within a week. By mid-February nearly all the burbot had left the shoal. Observations on the progress of the spawning activity on the shoal are outlined in Table 2. This table includes data collected from observations made through holes in the ice and from examination of burbot taken by daily netting.

Conditions for observing the actual spawning act were unsatisfactory because of the darkness beneath the snow-covered ice although a number of holes were opened to permit the entrance of light. It may be stated only that there was a great milling around of spawning burbot, and there was release of quantities of eggs, many of which seemed to be kept in temporary suspension by the water movements set up by the activity of the fish. Since the eggs are small and the ovaries are proportionately large, egg production is high (over one million eggs in a large female). Because of this high fecundity and because growth is rapid, the burbot has a tremendous reproductive potential.

Otoliths taken from a number of burbot were aged, giving the growth data presented in Table 3. All burbot taken on the shoal during the netting periods, except for a few small males, were mature fish.

Although burbot were practically exclusive occupants of the shoal during the prespawning and peak spawning periods, other species began to appear during the latter part of the spawning period and their numbers increased as the burbot began to leave the shoal. The most common of these species were the yellow perch (*Perca flavescens*), the common sucker (*Catostomus commersonnii*), and the common whitefish (*Coregonus clupeaformis*). The importance of these fish as predators on the burbot eggs was not determined.

In view of the difficulties entailed in studying the development of eggs on the spawning beds, a small number of burbot were spawned artificially and the eggs moved to a whitefish hatchery for incubation. The eggs were handled in a manner

TABLE 2.—OBSERVATIONS ON SPAWNING POPULATIONS OF BURBOT AT NOLAN'S SHOAL DURING WINTERS OF 1956 AND 1957

1956		1957	
Date	Observations	Date	Observations
Jan. 23–26	Burbot abundant on shoal; no ripe fish; 75 per cent male fish	Jan. 23–27	Burbot abundant on shoal; no ripe fish; 50 per cent male fish
Jan. 27–29	Males and females in equal numbers; a few males ready to spawn	Jan. 28–29	Some males ready to spawn; no ripe females
Jan. 30–31	Spawning underway with a few ripe females; most males ripe	Jan. 30	Spawning underway with a few ripe females
Feb. 1–5	Peak spawning period	Jan. 31–Feb. 3	Peak spawning period
Feb. 6–12	Majority of both sexes spent	Feb. 4–8	Majority of both sexes spent
Feb. 13–14	All females spent; a few ripe males; few burbot on shoal	Feb. 9–13	All females spent; a few ripe males; few burbot on shoal
Feb. 15	Project discontinued; ice unsafe	Feb. 14	Project discontinued; very few burbot on shoal
Number of burbot examined	1,353		606

TABLE 3.—LENGTH AND WEIGHT OF BURBOT TAKEN FROM THE SPAWING SHOAL

Age	MALES					FEMALES				
	Number	Total Length (inches)		Total Weight (ounces)		Number	Total Length (inches)		Total Weight (ounces)	
		average	range	average	range		average	range	average	range
III	15	17.9	(16.5–19.5)	25.6	(20–32)	1	18.5	-	32.0	
IV	11	18.4	(15.5–21)	44	(28–54)	2	18	(15.5–20.5)	50.5	(44–57)
V	8	22	(19–25.5)	52	(34–61)	2	21.5	(18–25)	57	(54–60)
VI	3	22.5	(20.5–25)	56	(48–60)	12	22.8	(21–24.5)	56	(52–64)
VII	12	25.6	(25–26.5)	72.8	(67–80)	10	25.2	(24.5–26)	68.0	(60–96)
VIII	6	27	(26–28)	88	(80–96)	22	26.8	(25–29.5)	86.8	(64–104)
IX	—	—	—	—	—	10	29.1	(28.5–30)	96.8	(92–104)
X	—	—	—	—	—	1	31		112	
XI	—	—	—	—	—	4	31.3	(30–31.5)	110	(102–112)
XII	—	—	—	—	—	1	33		152	

similar to that employed in whitefish culture. They were fertilized and allowed to water harden for 1 hour before being transported to the hatchery where they were placed in 6-qt. hatchery jars. By experimentation, it was found that the most suitable quantity of eggs was 2½ qts. (750,000 eggs) per jar. Because of the bouyancy of the eggs, the flow of water through the jars had to be reduced to a trickle.

Eggs which were collected and fertilized at Lake Simcoe on January 29th, 1957, were "eyed-up" by March 1st. Hatching began on April 10 when the water had warmed to 34° F. The newly-hatched fry were small, averaging only 0.16 in. in length. Although still carrying the weight of their yolk sacs, they were carried by the slight flow of water from the hatching jars to a retainer where they became active.

From these observations, it would appear that natural hatching in lake Simcoe should take place during the month of April. Unsafe ice conditions at that time made a study of the natural spawning beds impossible.

The mature burbot appeared not to feed during the prespawning and spawning period on Nolan's Shoal. However, the spawned-out fish that remained in the shoal area were found to be feeding heavily on yellow perch (*Perca flavescens*) which became numerous during the latter part of the spawning period. This observation on feeding coincides with earlier observations made on winter river-run burbot (McCrimmon and Devitt, 1954). In this case, postspawning runs of burbot were found to be preying extensively upon yellow perch and lake emerald shiner (*Notropis atherinoides*) which were abundant in the rivers at that time.

SUMMARY

A study was carried out between 1954 and 1957 to determine the spawning habits of the burbot (*Lota lota lacustris*) in Lake Simcoe. It was found that winter runs of burbot into the tributary rivers were for the purpose of feeding rather than for spawning as previously supposed. These runs occurred largely in the postspawning period. The investigation was then transferred to the open lake. Upon locating a shoal on which burbot spawned, observations were made on the nature of the spawning bed and upon spawning characteristics.

Mature burbot arriving at the shoal after mid-January spawned in late January and early February. The majority of these fish had left the shoal by mid-February. By this time numbers of yellow perch, common sucker, and whitefish frequented the area.

In the hatchery, burbot eggs hatched in mid-April. Adult fish did not feed during the spawning period but began to prey heavily on forage fish in the lake and tributary rivers immediately after spawning.

LITERATURE CITED

MACKAY, H. H. 1957. The burbot (*Lota lota*). Sylva, 13(4):25–31.

MCCRIMMON, H. R. 1956. Fishing in Lake Simcoe. Publ. Ontario Dept. of Lands & Forests. pp. 125–128.

——— AND O. E. DEVITT. 1954. Winter studies on the burbot *Lota lota lacustris*, of Lake Simcoe, Ontario. Can. Fish Culturist, 16:34–41.

SPEIRS, J. MURRAY. 1952. Nomenclature of the channel catfish and the burbot of North America. Copeia, 2: 99–103.

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PREVENTION OF BROWSING BY DEER IN A PINE PLANTATION

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Very severe fall and winter deer browse damage has occurred during the past four years in a young plantation in Lower Michigan composed of white pine (*Pinus strobus*), red pine (*Pinus resinosa*), and jack pine (*Pinus banksiana*). The exact location of this study was the east 100 acres of the NW¼ of Section 8, T14N, R6W, Isabella County, which is approximately in the geographic center of the Lower Peninsula of Michigan. The area is rolling and is crossed by a high moraine known as Bundy Hill. According to early descriptions, the area soils are mapped as Coloma sand, a light droughty soil that formerly supported white pine. The slopes and top of the moraine are fairly open with scattered dense growths of staghorn sumac (*Rhus typhina*) interspersed with a few thickets of quaking aspen (*Populus tremuloides*) encroaching into the area. A few red maple (*Acer rubrum*) have seeded in by old stumps and some sugar maple (*Acer saccharum*), white oak (*Quercus alba*), and white ash (*Fraxinus americana*) are scattered on the highland. The lowlands are forested with an over-story of mature, large-tooth aspen (*Populus grandidentata*) about 40 years of age, with an undergrowth consisting chiefly of red maple, white ash, red oak (*Quercus borealis*), American beech (*Fagus grandifolia*) and sassafras (*Sassafras albidum*).

About 8,000 seedlings and transplants of the aforementioned pine species have been planted on the slopes and open areas on top of the moraine. Approximately 75 per cent of these trees have been browsed to a lesser or greater degree. Damage incurred has destroyed terminal buds promoting lateral, bushy growth, and in many instances has killed the tree by destroying all the buds. Three reasons account for excessive deer population and resulting damage in this locality. (1) There is a large amount of sumac, a favorite browse food, and other suitable deer food in this area. (2) This area is surrounded by privately-owned lands with restricted hunting which has resulted in a very small deer kill. (3) Does are not legal game here.

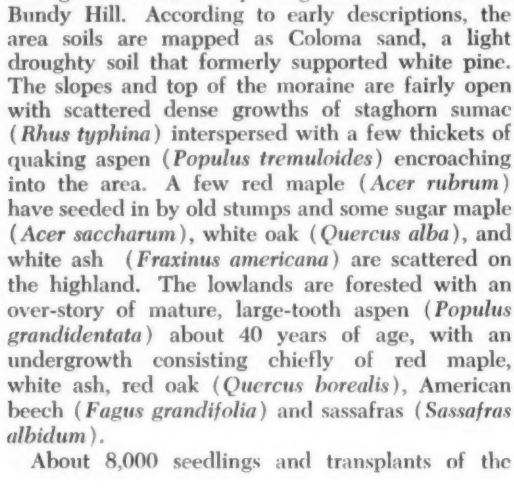

FIG. 1. Deer ate all buds on this red pine except the protected terminal bud.

To cope with the damage problem, it was decided that some method of covering and protecting the buds should be attempted. Polyethylene plastic, well known for such uses as construction work and greenhouse covering, seemed a suitable material for trial.

In the fall of 1958, as deer damage was commencing, the terminal buds and some lateral buds of 500 pine including all three species were covered with pieces of plastic stapled securely. Pieces 3″ × 4″ were found adequate to cover the buds and allow sufficient surplus for stapling the ends of the plastic together. Two methods of covering the buds were used. On some trees the plastic was folded down over the tops of the buds. On the other trees the plastic was wound around the buds and stapled, as shown in Figure 1. Both methods prevented deer damage to the covered buds. The latter method described is more satisfactory, however, as the plastic is easier to apply and is more quickly removed by simply pulling the cover upward over the buds without removing any staples. Also, this method does not distort growth of new spring shoots should the plastic not be removed early enough in spring.

Results obtained can be seen in the figure. New spring growth is occurring from protected portions, whereas buds on unprotected trees were eaten and no growth occurred. In many cases where the terminal bud was protected, it was the only living portion from which new growth was established, all other unprotected buds being eaten. In many cases, unprotected buds below the snow level were unharmed.

Application of the plastic is best accomplished by two men, one carrying the plastic pieces, the other covering and stapling the plastic around the tree portion containing the bud. It was found that the terminal buds of 150 to 200 trees can be covered in 1 hour by this procedure, where tree spacing is approximately 8 feet apart.

The cost of materials is small. Light-weight plastic, two-thousandths of an inch in thickness and known as number 2, is very satisfactory, and retails for about 2½ cents a square foot, an amount sufficient to cover 12 trees. One dollar's worth of plastic will protect approximately 480 trees.

Some questions regarding the use of plastic for this purpose were answered this spring following a winter's test. It was thought that water formed from respiration of the living tissues might accumulate and freeze under the plastic coverings, and kill the buds. In every case, covered buds survived, with winter temperatures reaching –20°F. It was likewise noted that shoots from plastic-covered buds began growth earlier in spring and were consequently longer. Apparently, the heat afforded by the plastic stimulated growth. It is advisable, however, to remove the coverings as soon as growth starts in spring and danger from deer damage is over, to allow for normal shoot development. None of the plastic-protected buds were bothered by deer. It had been noted earlier, before this experiment was attempted, that those buds naturally covered by upturned needles were less likely to be eaten than exposed buds. Hence, there was reason to believe that deer would not molest plastic-covered buds. The plastic was found to be very durable and held firmly through the winter, in spite of high winds and snow that swept across the moraine.

The use of polyethylene plastic as a protection against deer browse damage was found to be completely satisfactory. Its use can be recommended in any type of plantation, whether for Christmas trees, windbreak, soil erosion, or ornamental purposes, where deer damage is likely to occur.

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BREEDING OF SUBADULT COTTONTAIL RABBITS IN OHIO

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During the years 1952 through 1955, I undertook a study of cottontail rabbit (*Sylvilagus floridanus mearnsi*) reproduction in Ohio. The present paper provides information concerning the earliest age at which cottontail rabbits are capable of reproducing as well as the relationship of birth date to attainment of sexual maturity. Financial support for this work was provided by the Ohio Cooperative Wildlife Research Unit and the Wildlife Management Institute. The advice and encouragement of Dr. E. H. Dustman, Unit Leader, is gratefully acknowledged.

In a previous paper (Negus, 1958) I have described the pelage stages by which Ohio cottontails may be assigned to several age groups. Briefly, these stages consist of nestling fur, molt to juvenile pelage, juvenile pelage, molt to subadult pelage and subadult pelage. Subadult pelage is of the greatest value in regard to the present paper since it serves to distinguish young rabbits from adults even if they have attained adult proportions. The age range of subadult pelage extends from about 15 to more than 30 weeks of age. Rabbits in this age group frequently attain sexual maturity during the summer in which they are born.

Some workers contend that young cottontails do not usually breed during the season in which they are born. Cooley (1946), however, summarizing six years of work on the cottontail in Michigan, cited three records of young females breeding or sexually active in their first season. Hendrickson (1947) and Bruna (1951) each cited one record of sexual activity in a young female in her first season. Sowls (1957) cited 11 records of female *Sylvilagus auduboni* breeding in their first year in Arizona. Reproductive activity in young rabbits has been recorded also by Ingles (1941), Bowers (1955), Ecke (1955), and Lord (1958).

During the present study 67 female rabbits were examined that were classed as subadults on the basis of complete or nearly complete subadult pelage. Some of these animals were killed while others were released following examination in the field. When a subadult female was killed, one entire forefoot was saved for X-ray examination. In all cases where forefeet were saved, X-ray examination confirmed that they were young of the year on the basis of ossification of the distal epiphyseal cartilage of the radius and ulna as well as ossification of the proximal end of the humerus. Animals were considered to be reproductively active if they possessed any of the following characteristics: visible pregnancy, placental scars, a state of lactation, or distention of the uterus and presence of mature follicles and/or corpora lutea in the ovaries. Ovaries were sectioned at 40–50 microns thickness, stained with Delafield's hematoxlyn and eosin red and examined under a microscope.

In a sample of 36 subadult females from the unglaciated Allegheny Plateau of Ohio, 18 (50 per cent) were found to be reproductively active during

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their first year. Twenty of these animals were taken from fenced five-acre plots in Coshocton County where the Ohio Division of Wildlife was conducting rabbit studies. Eleven of these animals were sexually mature. Of sixteen subadults obtained from a selected study area in Muskingum County, seven were reproductively active or sexually mature.

In a sample of 30 subadults from the till plain region of Ohio, ten (33 per cent) were reproductively active during their first year. Of eleven of these animals obtained during the 1952 breeding season, six were reproductively active. During the 1953 season 17 subadults were obtained from this region. Only two of these animals showed definite signs of reproductive activity. Two subadult females examined in 1954 from the till plain region were reproductively active.

The apparent low rate of subadult breeding in 1953 may be related to the fact that as late as April 26 more than 50 per cent of the adult females from a sample of 37 taken at the Urbana State Game Farm were not yet pregnant with their first litters. This suggests that birth dates of first litters of the year may have considerable influence on the amount of subadult breeding in a cottontail population during any one season. The average birth date of first litters of the year may be highly variable from one year to the next. This is evidenced by a sample of 15 adult females collected during April, 1954, in the till plain region. Seven were pregnant with their second litters, six were pregnant with their first litters, and two were lactating but not noticeably pregnant with second litters. Thus, in the same month of two successive years, there is a striking difference in the progression of the breeding season early in the spring.

In order to gain some idea of the age at which young rabbits attain sexual maturity, an approximate age in months was assigned to each young rabbit examined on the basis of pelage and weight compared to an age-weight curve for known-age cottontails (Petrides, 1951). On this basis no subadults were found reproductively active that were judged to be less than eight months of age by the end of the year in which they were born. This suggests that rabbits born later than April would not be expected to breed during their first summer. However, some individuals that were judged to have been born much earlier than the end of April were not reproductively active. Apparently, there is considerable variation in the age at which sexual maturity is attained. Further variation is evident when we consider the data of two subadults that were known to have produced two litters in their first season. One individual from Coshocton County was judged to be six months old at the time she was collected on August 7, 1953. She was pregnant with her second litter as evidenced by lactation, placental scars and corpora albicantia in the ovaries. Another rabbit captured on August 23, 1954, in Muskingum County was pregnant with her second litter at the time of capture. She was probably a little over four months old at the time of capture. By aging of second-litter embryos and back-dating, I estimated that she had experienced her first fertile mating at the age of 2.5 months!

The relationship of age of sexual maturity to time of birth in cottontails is suggestive of the observations by Barbahenn (1955). His data suggest that voles (*Microtus pennsylvanicus*) born after mid-June do not grow as rapidly as those from earlier spring litters. It is conceivable that this may be related to seasonal changes in the nutritional quality of the vegetation. During my own studies a series of 25 blue grass samples, collected randomly and analyzed quantitatively for mineral content, indicated an appreciably higher calcium content in blue grass from May through June (1.25–1.69 per cent) than mid- and late August samples (.40–.82 per cent). Nutritional research on wild animals as well as seasonal physiological changes in plants are areas that warrant much further investigation with respect to the effects upon population dynamics.

When the entire sample of subadults is considered, 42 per cent of the animals examined from 1952–55 were reproductively active. On the basis of the number of embryos in four pregnant animals and one set of fresh placental scars, the mean litter size for subadult rabbits was 4.0 with extremes of 3 and 5. This is considerably smaller than the mean (5.5) which I have determined from 124 litter sizes of adult cottontails in Ohio. It should be emphasized that the amount of subadult breeding in any year is probably dependent largely upon the success of adult breeding early in the season.

REFERENCES CITED

BARBAHENN, KILE R. 1955. A field study of growth in *Microtus pennsylvanicus*. J. Mammal., 36:533–543.

BOWERS, GLANN L. 1955. Unusual breeding of cottontails in Pennsylvania. J. Mammal., 36:303.

BRUNA, JOE. 1951. Kentucky rabbit investigations. Paper presented at 5th Southeast Wildlife Conf. 21pp. (mimeo.)

COOLEY, MARVIN E. 1946. Cottontails breeding in their first summer. J. Mammal., 27:273–274.

ECKE, DEAN H. 1955. The reproductive cycle of the Mearns cottontail in Illinois. Amer. Midl. Nat., 53: 294–311.

HENDRICKSON, GEORGE O. 1947. Cottontail breeding in its first summer. J. Mammal., 28:63.

INGLES, LOYD G. 1941. Natural history observations on the Audubon cottontail. J. Mammal., 22:227–250.

LORD, REXFORD D., JR. 1958. The importance of juvenile breeding to the annual cottontail crop. Trans. N. Amer. Wildl. Conf., 23:269–276.

NEGUS, NORMAN C. 1958. Pelage stages in the cottontail rabbit. J. Mammal., 39:246–252.

PETRIDES, GEORGE A. 1951. The determination of sex and age ratios in the cottontail rabbit. Amer. Midl. Nat., 46:312–336.

SOWLS, LYLE K. 1957. Reproduction in the Audubon cottontail in Arizona. J. Mammal., 38:234–243.

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DUCK FOOD HABITS IN SOUTHWESTERN LOUISIANA MARSHES FOLLOWING A HURRICANE

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Weather is one of the most important factors affecting the welfare of many wildlife species. Although there are many references in literature concerning mortality caused by weather, there are few that evaluate the effects of storms on the food of birds and mammals.

The purpose of this study was to determine the foods eaten by ducks during the fall and winter after a disastrous hurricane on the Louisiana Coast and compare them with the foods eaten by ducks during the fall and winter prior to the storm. The food habits study made in the same general area before the hurricane was performed by Chamberlain (1959).

The material for this study was collected by Allen Ensminger, and used as a master's thesis in the School of Forestry, Louisiana State University.

The Hurricane

On the morning of June 27, 1957, hurricane "Audrey" struck the Southwestern Louisiana Gulf Coast with a force completely unequaled in memory of those who live in the region. The storm resulted in disastrous losses of human life and property in Cameron, Iberia and Vermilion Parishes. Great numbers of wild and domestic mammals, birds and reptiles were drowned in the marshes.

According to Yancey (1958) water level readings reached 11.3 feet above sea level and winds exceeded 100 m.p.h. In general the marshes are only about 1 to 2 feet above sea level and the effects of the hurricane resulted in complete inundation by waters from 7.3 to 10.3 feet in depth for a great distance inland from the coast. The normal tidal range is 1.5 to 2.0 feet. The highest elevations, that is, stranded beaches, Indian mounds and levees, were submerged beneath the wind-driven tide.

Large mats of vegetation were torn loose from the marsh floor and deposited in bayous, lakes, and in long wind rows at the upper reaches of the flood tide or swept into the Gulf by the receding water. This caused a large increase in the acreage of open water in the marsh. The marsh had been saturated by frequent rains preceding the hurricane. This condition plus continued heavy rains following the storm alleviated much of the damage that would have been caused by inundation with salt water. Above-normal water levels which remained in the marsh throughout the summer and fall resulted in an even greater acreage of open water. These high water conditions were detrimental to the production of fur animals and to livestock grazing. The immediate value of much of the marsh was greatly reduced for waterfowl since many food producing plants were scoured out by debris and currents. Nevertheless, much growth was made after the storm and by the time migrant waterfowl arrived the marsh was again partially productive.

Methods

Chamberlain (1959) analyzed the contents of 1,251 gizzards removed from 17 species of waterfowl. These gizzards were collected during the fall and winter of 1955–56 and during the fall and winter of 1956–57, one and two years prior to the hurricane. The writers analyzed the contents of 172 gizzards removed from 9 species of waterfowl taken from the same marshes. These gizzards were collected in 1957–58 during the first fall and winter following the storm.

Discussion of Results

The results of this study show that 19 plant families comprising 45 species and 13 animal foods were utilized as food by waterfowl.

The 5 principal duck foods expressed as per cent of the total volume of food, were: *Cyperaceae* 53.5; *Gramineae* 12.4; *Cyprinidae* 9.2; *Zosteraceae* 5.2; and *Astacidae* 2.7 per cent (Scientific names from Gray's Manual of Botany, Eighth Ed., 1950). The remaining 16 plant families and animal foods made up only 17.0 per cent of the total food found in gizzards.

Sawgrass (*Cladium jamaicense*) was the most frequently eaten plant species. It occurred in 98.3 per cent of all gizzards and comprised 35.0 per cent of the total volume of food consumed. Chamberlain (1959) found that sawgrass occurred in 72.5 per cent of the gizards analyzed and made up 25.0 per cent of the total volume of food. The results of these two studies show that the hurricane of June, 1957, had little effect on the amount of sawgrass seed eaten by ducks. At one time, dense stands of sawgrass occupied large areas in the marsh; but for about four years just prior to the hurricane, there was very little sawgrass vegetation in the area studied. Therefore, the seeds of sawgrass must remain available in the muck layers over a long period. Dillon (1957) states that gizzard analysis may show an exaggerated daily consumption of some hard seeded plants from 2 to 10 times (or even more) whether measured by volume or frequency. Kimble (1958) showed that a chemical analysis of sawgrass seeds indicated that they have a fairly high nutritional value, and in addition, ducks may use them as a supplement to grit because of their hardness. Table 1 lists the constituents of sawgrass, rice and millet seeds. Bullwhip (*Scirpus californicus*) occurred in 72.7 per cent of the gizzards examined and made up 9.4 per cent

TABLE 1.—THE NUTRITIONAL VALUE OF SAWGRASS, RICE AND WILD MILLET SEEDS

Plant Species	Moisture	Crude Protein	Fats	Ash	Crude Fiber	Nitrogen-free Extract
Sawgrass	5.6	6.3	2.2	8.6	32.1	45.2
Domestic rice	12.4	7.4	0.4	0.4	0.2	79.2
Wild millet	12.0	11.1	3.7	2.6	7.7	62.9

NOTE: All figures are expressed as per cent.

of the total volume of food consumed. It was the second most important plant eaten by ducks during this study and was ranked 12th by Chamberlain (1959). This plant species was utilized heavily by ducks following the hurricane, probably because high water levels were favorable to the growth, spread, and production of seed of this species, but, at the same time the hurricane was detrimental to some of the more preferred duck food plants. Spikerush (*Eleocharis* spp.), leafy three-square (*Scirpus robustus*), smartweeds (*Polygonum* spp.), heliotrope (*Heliotropium* sp.), and some other plants were utilized about equally by frequency and by volume during both studies. These plants occurred in about 75 per cent of the gizzards and made up 6.2 per cent of food during both studies. This indicates that the storm had very little effect on the availability of the seeds of these plants. Both the seed and the foliage of widgeon grass (*Ruppia maritima*) occurred in much greater amounts and more often in gizzards examined during this study than they did in gizzards analyzed by Chamberlain. This plant species was rated fifth in importance by the writers while it was ranked 13th by Chamberlain. The abnormal high tides during the hurricane probably distributed this aquatic plant throughout the marshes in Southwest Louisiana. An influx in the volume of salt water and the slow run off in these areas resulted in a more favorable environment for the survival, growth, and spread of this plant. Domestic rice (*Oryza sativa*), wild millet (*Echinochloa* spp.), and other plants associated with their culture occurred less frequently, but in larger volume in the study conducted after the hurricane. These plants occurred in approximately 25 per cent of the gizzards and made up only 7.2 per cent of the total volume of food eaten by ducks during this study. Chamberlain found *O. sativa* and *Echinochloa* spp. occurred in 15.2 and 34.0 per cent respectively of the gizzards examined and made up 3.4 and 13.1 per cent respectively of the total volume of food. More suitable feeding areas were made available to ducks in the marshes as a result of higher water levels, therefore, ducks probably did not feed in the rice fields as often as they did during the winter prior to the hurricane. Saltgrass (*Distichlis spicata*) occurred occasionally as a trace in the gizzards during this study, but was second in importance in Chamberlain's study. This is probably the result of low seed production caused by high water following the hurricane. However, the seeds of salt grass are very light and may have floated into the Gulf. *Cyperus* spp. was found to be an important food in the duck gizzards analyzed by Chamberlain, but was used infrequently and in small quantities by ducks during this study. Chamberlain found *Cyperus* and its related species growing abundantly on the berms of levees in the late summer and fall in the Grand Cheniere area. Following the hurricane, deep water over these areas during the growing season probably resulted in low seed production and reduced growth and spread of *Cyperus*. Several other minor plant species occurred rather infrequently and in trace amounts before and after the hurricane of June, 1957.

A review of Table 2 shows that animal material occurred much more frequently and in larger quantities in this study than it did in Chamberlain's study. Small fishes in the minnow family made up more than one-half of the total animal food consumed by ducks. A variety of animal matter such as crayfish, shrimp, crabs, mollusks, snails and insects made up the remaining animal food. The occurrence of animal food in the gizzards examined from mallards (*Anas platyrhynchos*), pintails (*A. acuta*), and blue-winged teal (*A. discors*) increased considerably during the latter part of the hunting season. The increase in animal material is probably associated with more water over the feeding areas during the winter of 1957–58 than during 1956–57.

SUMMARY

Large tidal waves caused by the hurricane of June, 1957, inundated a large portion of the marshes. Due to the low relief and the frequent rains during the year, the water remained over the area for several months. Since flooding occurred during the height of the growing season, some plants were completely eliminated, seed production was impaired on others, but certain aquatic plants increased. The comparison of the results of a food habits study of waterfowl before with one after the

TABLE 2.—A COMPARISON OF DUCK FOODS BASED UPON PER CENT VOLUME DETERMINATIONS IN TWO STUDIES

Rank	Pre-Hurricane Analysis by Chamberlain, 1959	Post-Hurricane Analysis by Kimble, 1958
1	*Cladium jamaicense*	*Cladium jamaicense*
2	*Distichlis spicata*	*Scirpus californicus*
3	*Echinochloa* spp.	*Eleocharis* spp.
4	*Eleocharis* spp.	Minnows
5	*Scirpus robustus*	*Ruppia maritima*
6	*Brasenia schreberi*	Snails
7	*Cyperus* spp.	*Brasenia schreberi*
8	*Paspalm* spp.	*Polygonum* spp.
9	*Oryza sativa*	*Paspalum plicatulum*
10	*Scirpus californicus*	*Echinochloa* spp.
11	*Heliotropium* sp.	Insects
12	*Panicum* spp.	*Najas guadalupensis*
13	*Ruppia maritima*	Crayfish
14	*Polygonum* spp.	*Oryza sativa*
15	*Cuscuta* sp.	*Paspalum urvillei*

hurricane indicates a great difference in the foods eaten by ducks. Some foods such as *Cyperus*, widgeon grass, domestic rice, bullwhip, and some animal foods were found to be an important food of waterfowl in one study while the same kind of foods were found to have been a minor item in the other study.

In general the hurricane of June, 1957, had a temporary damaging effect on the vegetation in the marsh near Grand Cheniere, but by the time of arrival of wintering waterfowl most of the vegetation had recovered. The storm benefitted wintering waterfowl by opening up landing and feeding areas in dense stands of vegetation.

LITERATURE CITED

CHAMBERLAIN, J. L. 1959. Gulf coast marsh vegetation as food of wintering waterfowl. J. Wildl. Mgmt., 23 (1):97–102.

DILLON, O. W., JR. 1957. Food habits of wild ducks in the rice-marsh transition area of Louisiana. Proc. 11th. Ann. Conf. SE. Assn. Game & Fish Comms., 114–119 (1958).

FERNALD, M. L. 1950. Gray's manual of botany. American Book Co., New York, 8th Ed., 1,632pp.

KIMBLE, R. B. 1958. A food habits study of ducks in Cameron Parish, Louisiana following the hurricane of June 1957. Unpub. master's thesis, La. St. Univ., Baton Rouge, 70pp.

YANCEY, R. K. 1958. Effect of hurricane "Audrey" on the coastal refuges of Southwest Louisiana. Seventh Biennial Rept., Louisiana Wild Life and Fish. Comm., 1956–57, pp. 51–64.

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SUMMER BROWSE PREFERENCES OF ADIRONDACK WHITE-TAILED DEER

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Evaluation of deer browse preference is usually difficult, perhaps often impossible, because of previous selective browsing by deer on the vegetation to be evaluated. In areas of high deer population the most preferred plant species may be so heavily utilized that they are drastically reduced in availability or even extirpated from the environment. Therefore, browse habits may only reveal deer preference for plant species quite low on the preference list.

In 1958 there was a unique opportunity to determine summer browse preference for Adirondack white-tailed deer (*Odocoileus virginianus borealis*) on an area not browsed by deer for over 18 years. An exclosure fence was knocked down by falling trees and one or more deer spent a short time browsing in a "virgin field" before the fence was repaired.

The exclosure is on the Archer and Anna Huntington Wildlife Forest in a heavily forested section of the central Adirondacks where there are few natural or man-made openings in the crown canopy. The two acre area had been closed to deer browsing from the time of fence establishment in 1939 until portions of the fence were removed for a short time in 1955. At this time 50 per cent of the crown canopy was removed by logging. The fence was reestablished after only a few weeks. Because of the large volume of tree tops on the ground in this short period, deer had very little influence on the living vegetation. Details on status of vegetation in the exclosure are given by Webb, *et al.* (1956).

In June 1958 two trees came down across the exclosure fence, opening the area to browsing for a short time. A search for deer pellet groups was made on 144 milacre plots within the fenced area. Two pellet groups found on this sample area indicated 13.9 pellet groups per acre. Since the exclosure is a little over two acres it seems reasonable to assume a total of approximately two deer-days of use of the area. There was no indication that deer had been inside the exclosure fence except for a short period of time, as no old deer droppings were found either on the sample plots or elsewhere within the fence. It seems likely that the trees fell across the fence on June 16 or 17 during a very windy period. Since the fence was repaired on June 27, presumably all deer browsing took place in this 10-day period.

Vegetation available for deer browsing was counted on 36 yard-square sample plots within the exclosure fence by listing all stems present. Each plant was carefully examined for signs of browsing. These data are presented in Table 1 with the per cent of stems browsed as an index to preference.

It is clear that beech is not used any more as summer browse than it is in the winter time. Witch hobble, the staple winter deer food of the area, is not utilized as a summer browse. Hard maple, red raspberry, and white ash are utilized as summer browse, but they can not be considered preferred foods as they are used in about the same proportion as they are available. Yellow birch and black cherry are apparently preferred summer foods but their utilization is low compared with that of alternate-leaved dogwood and elderberry which are highly

TABLE 1.—NUMBER OF STEMS AVAILABLE AND NUMBER BROWSED IN TWO DEER-DAYS OF USE OF ADIRONDACK VEGETATION, JUNE, 1958

Species	Number Stems on 36 Square Yards		Per Cent of Stems Browsed
	Available	Browsed	
Hard Maple *Acer saccharum*	467	6	1.3
Red Raspberry *Rubus idaeus*	124	3	2.4
Yellow Birch *Betula alleghaniensis*	54	4	7.4
Witch Hobble *Viburnum alnifolium*	45	0	0
Beech *Fagus grandifolia*	44	0	0
White Ash *Fraxinus americana*	19	1	5.3
Alternate-leaved Dogwood *Cornus alternifolia*	16	11	68.8
Elderberry *Sambucus pubens*	12	8	66.7
Black Cherry *Prunus serotina*	11	1	9.1
Pin Cherry *Prunus pensylvanica*	4	0	0
Trembling Aspen *Populus tremuloides*	2	0	0
Striped Maple *Acer pensylvanicum*	2	0	0
Honeysuckle *Lonicera canadensis*	2	0	0
Mountain Maple *Acer spicatum*	1	0	0
Red Spruce *Picea rubens*	1	0	0
Total	804	34	4.2

preferred since more than two-thirds of the stems are utilized. Elderberry occurs fairly commonly in openings in the forest where mineral soil is exposed. It is usually heavily browsed by deer in the summer season. However, alternate-leaved dogwood is so uncommon outside the exclosure fence that it was not found by an experienced botanist in two summers of collecting in this region. Perhaps deer browsing of this highly preferred species is the factor which limits its abundance.

There was no indication that deer had utilized herbaceous plants present inside the exclosure.

LITERATURE CITED

WEBB, W. L., R. T. KING, AND E. F. PATRIC. 1956. Effect of white-tailed deer on a mature northern hardwood forest. J. Forestry, 54(6):391–398.

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RESPONSE OF *LESPEDEZA BICOLOR* TO LIME, PHOSPHATE, AND POTASH[1]

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Lespedeza bicolor is the species most commonly planted for quail food in Alabama. Very few experimental data are available concerning its lime and fertilizer requirements. Plantings in the state are frequently observed showing apparent nutritional deficiencies. Observation showed that when patches planted from seed failed, failures occurred during the first year. Droughty conditions at the time when seedlings had just come up often resulted in failure of the patches. This perennial legume is generally grown on poor or eroded soils in abandoned fields or at the edge of wooded areas where the soil is usually low in phosphate (P_2O_5) and potash (K_2O) and frequently very acid. The objective of this test was to determine if applications of lime, P_2O_5, and K_2O would substantially increase

TABLE 1.—YIELD OF *Lespedeza bicolor* PLANTS (FOLIAGE) FROM RATES OF LIME, PHOSPHATE, AND POTASH

Number	Treatment (pounds per acre)			Yield[1] dry wt. (gms. per pot)
	Lime	P_2O_5	K_2O	
1	0	100	100	30.6
2	1000	100	100	46.6
3	2000	100	100	56.0
4	4000	100	100	74.6
5	2000	0	100	10.0
6	2000	50	100	41.4
7	2000	100	0	24.0
8	2000	100	50	34.2

[1] Average of 3 replications.

[1] Jointly financed by the Alabama Department of Conservation, Alabama Polytechnic Institute, U.S. Bureau of Sport Fisheries and Wildlife, and the Wildlife Management Institute.

[2] Present Leader of the Iowa Cooperative Wildlife Research Unit, Iowa State College, Ames, Iowa.

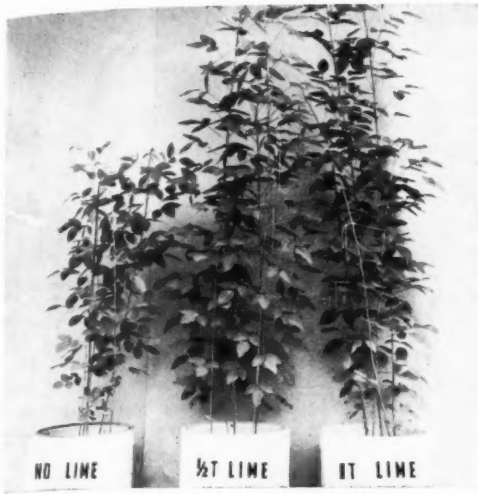

Fig. 1. Response of *Lespedeza bicolor* to lime.

first season growth of the plant and thereby speed its establishment and production.

Experimental Procedure

A Norfolk sandy loam was obtained near Hatchechubee, Russell County, in the general area of several large quail preserves in the southeastern part of Alabama. The soil was dried, screened, and 16 pounds potted into each of twenty-four 2-gallon glazed pots. Lime and fertilizer were thoroughly mixed with the soil, at the rates shown in Table 1. Inoculated seed was planted and thinned to four plants per pot. All treatments were replicated three times. Vegetative growth was determined by harvesting plants at the flowering stage and reported as dry weight per pot.

Results and Discussion

The soil used in this experiment was low in P_2O_5 (17 pounds per acre) and K_2O (62 pounds per acre) and had a pH of 4.9. This is typical of many areas where *Lespedeza bicolor* is grown. Results reported in Table 1 indicate a response to lime up to the maximum treatment of 4,000 lbs. per acre. The response to lime is illustrated in Fig. 1. The pH values for the soil at the end of tests for the three increments of lime were 5.2, 5.7, and 6.5. Applications of 50 and 100 pounds of P_2O_5 per acre increased yields 310 and 460 per cent respectively (Fig. 2). Application of 100 pounds of K_2O per acre increased yields 133 per cent (Fig. 3).

This greenhouse experiment showed that growth of *Lespedeza bicolor* to the flowering stage was greatly accelerated by applications of lime, phosphate, and potash. General observations indicate that growth of seedlings when they first emerged from the ground was speeded up considerably. Such response should result in increased and earlier success of patches established from seed, especially in areas where dry periods may result in a considerable loss of seedlings, as commonly occurs on the sandier soils in the Southeast. Since less labor and expense are involved in starting a patch from seed than in starting one with transplants, these findings may result in more frequent use of seed in establishing patches of bicolor for quail in the South.

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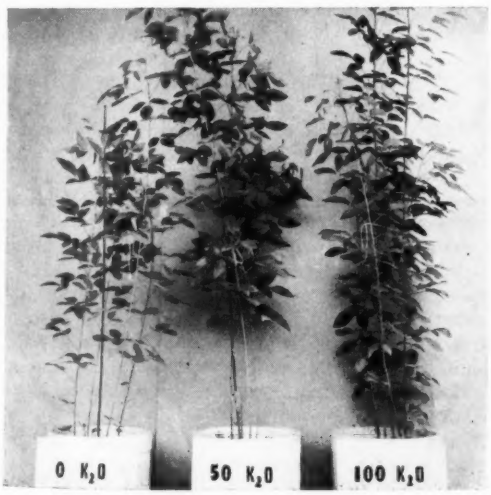

Fig. 2. Response of *Lespedeza bicolor* to K_2O.

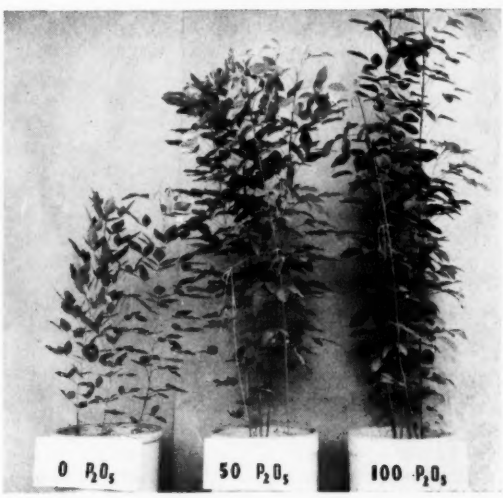

Fig. 3. Response of *Lespedeza bicolor* to P_2O_5.

COMPARISON OF EARLY MORNING AND SPOTLIGHT ROADSIDE CENSUSES FOR COTTONTAILS[1]

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The early morning roadside census has been used in many states to determine the relative abundance and distribution of cottontail rabbits (*Sylvilagus*). This paper presents evidence suggesting that greater numbers of rabbits are seen most months of the year when the roadside census is performed at night.

Considering its widespread use, little information has been published concerning the roadside census for rabbits. Hendrickson (1939) first described its use. His routes, only 5 miles long because they were intended to sample a small area, were relatively short. Newman (1957) described a more typical roadside census in a paper concerned with the influence of weather on the results obtained by this census method. The most common practice is regular driving of established routes 20 or 30 miles in length. The census is usually started 1 or 1½ hours before sunrise and is repeated within the same season annually. Various workers perform censuses during different seasons depending on their objectives. Wight (1959) reported results of 11 years of roadside counts made in July to obtain productivity information in addition to data concerning relative abundance of rabbits.

It is apparent that a census of this type may be much affected by the activity of rabbits. Weather, for example, can seriously affect results by curtailing or increasing activity. It is the thesis of this paper that a roadside census should be conducted during the daily peak of activity of rabbits because small differences in rabbit numbers when populations are low may be undetectable if *no* rabbits are seen during the census. During most months of the year (except summer months), the early morning census is performed at the end of the daily (nightly) activity curve. In addition, the early morning census is necessarily limited in time and distance covered by the rapidly changing light conditions which affect the activity of rabbits. As the light increases, activity subsides; this is true even in summer when the early morning census is most effective. Mykytowycz and Rowley (1958) have shown that the activity peak for the Australian rabbit (*Oryctolagus*) occurs at 10 p.m. in spring.

This paper describes the results of an extended series of nighttime roadside censuses carried out with the aid of a spotlight for a period of 17 months and compares results to those of early morning roadside censuses carried out on the same area.

Methods

In an effort to minimize effects of variables, early morning roadside censuses were made on several days during each month, and a mean figure was calculated for the month. To eliminate the effect of light variations due to cloud conditions, the point when a Weston light meter gave a reading of 3.2 incident light or 0.6 foot-candles (the meter was pointed toward the brightest part of the sky) signaled the time to start the census. On a cloudless day this amount of illumination occurs about half an hour before sunrise. This amount of light was selected as the minimum needed to see rabbits within 30 yards of the road without the use of binoculars or artificial light. The census was run on a 36-square-mile study area of intensively cultivated farmland near Sibley in central Illinois. Because of the time restriction the route was 31 miles long and was limited to the central 12 sections of the study area. On occasion the basic route was modified when some of the dirt roads became impassable due to rain. Censuses usually were not run during rain; if rain started after the census was begun, the census frequently was discontinued. A speed of about 20 m.p.h. was maintained during the census.

The spotlight census was usually started between 8 and 9 p.m., always at least an hour after dark. Because there were no important limitations on the length of the census route, and a determination of the distribution of rabbits was one of the principal objectives, roads of the study area were run in different patterns on different occasions. An average of 82.2 per cent of all road-miles were run each census. This helped to eliminate the possibility of arriving regularly at the same portion of the study area at the peak of nocturnal activity and thus causing bias in distribution data. All spotlight censuses were longer than early morning roadside censuses and covered the entire 36-square-mile study area. To aid in seeing the rabbits, I held a 12-volt hand spotlight out of the window, searching an arc of about 30 degrees while driving the car about 20 m.p.h.

Results

The average rate of speed traveled during 65 early morning roadside censuses was 19.81±5.41

[1] A contribution from Illinois Federal Aid Project No. 42-R, the Illinois Department of Conservation, the U.S. Bureau of Sport Fisheries and Wildlife, and the Illinois Natural History Survey cooperating.

[2] The author is employed by the Illinois Department of Conservation under terms of the Federal Aid in Wildlife Restoration Act and assigned to the Illinois Natural History Survey for administrative and technical supervision.

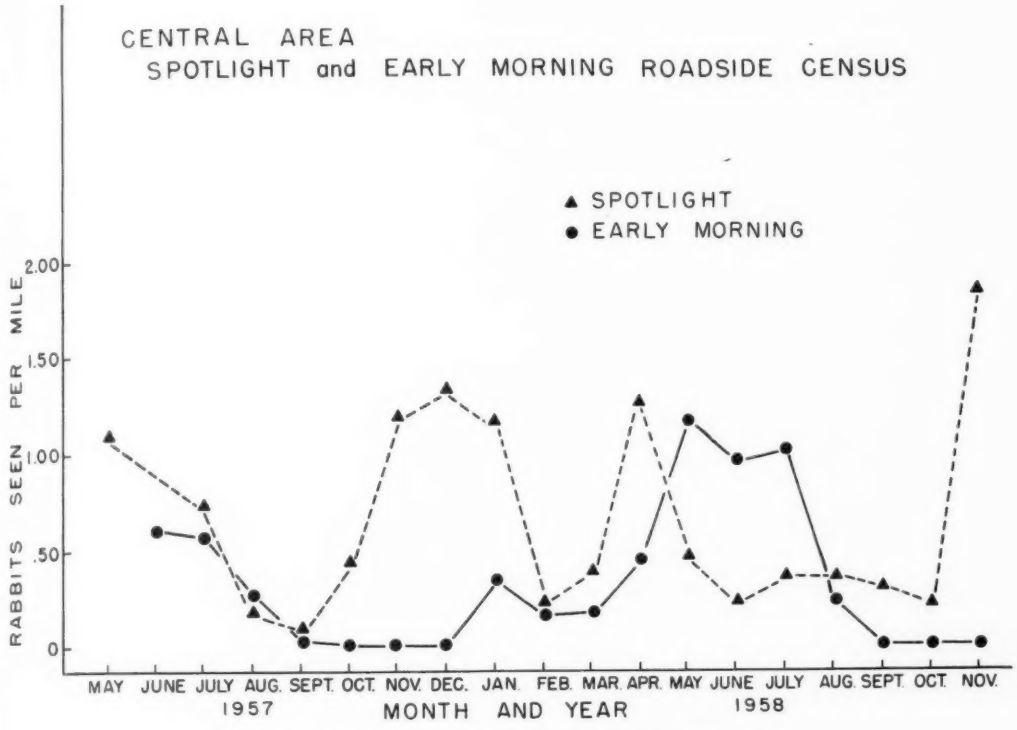

FIG. 1. Results of early morning and spotlight censuses on the central 12 square miles of the study area.

m.p.h. The average rate of speed traveled during 29 spotlight censuses was 21.76±2.98 m.p.h. Early morning censuses were always 31 miles long, but spotlight censuses averaged 63.3±11.6 miles. Figure 1 shows a graphical representation of the fluctuations of the two censuses through the seasons. This figure compares the number of rabbits seen on roads of the central 12-square-mile area during the spotlight censuses with the early morning roadside census of these same roads.

DISCUSSION

Figure 1 shows that for eight months of the year, from September through April, more rabbits were seen per mile during the spotlight census than during the early morning roadside census. However, for three of the summer months, May, June and July, more rabbits were seen per mile during the early morning roadside census than during the spotlight census. In August, during the two years of the study, the two censuses alternated in showing higher averages. Thus it seems that except for the summer months the spotlight census is superior to the early morning roadside census from the standpoint of numbers of rabbits seen per mile of census route. This conclusion is to be expected if the peak of rabbit activity is nocturnal for most of the year. The fact that the spotlight census does not reveal as many rabbits as the early morning census during the summer indicates a change in the daily activity pattern during those months.

ACKNOWLEDGMENTS

I am grateful to David Casteel, Richard Clark and James Kelly for aid in performing some of the censuses. I am indebted to the editorial committee of the Section of Wildlife Research of the Illinois Natural History Survey and to Dr. Thomas G. Scott for advice in the preparation of the manuscript.

SUMMARY

A series of early morning and nighttime roadside censuses of cottontail rabbits was performed on a study area in central Illinois farmland over a period of 20 months. Comparison of results of the two censuses indicates that for 8 months of the year greater numbers of rabbits are observed when the census is conducted at night. Only the summer months are better for the early morning roadside census.

LITERATURE CITED

HENDRICKSON, G. O. 1939. Inventory methods for Mearns cottontail. Trans. N. Amer. Wildl. Conf., 4:209–215.

MYKYTOWYCZ, R. AND IAN ROWLEY. 1958. Continuous observations of the activity of the wild rabbit *Oryctolagus cuniculus* (L.), during 24-hour periods. CSIRO Wildl. Res., 3:26–32.

NEWMAN, DUANE E. 1959. Factors influencing the winter roadside census of the cottontail. J. Wildl. Mgmt., 23(3):290–294.

WIGHT, HOWARD. 1959. Eleven years of rabbit population data in Missouri. J. Wildl. Mgmt., 23(1):34–39.

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LONGEVITY AND RANGE OF A CRIPPLED TURKEY TOM

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On March 27, 1958, I bagged a crippled Eastern wild turkey gobbler (*Meleagris gallopavo silvestris*) whose physical defect aided in compiling positive data. Mosby and Handley (1943) report only a limited number of records of deformed wild turkeys are available.

In early April, 1955, I first observed this tom, hopping and strutting on his left leg beyond gun range. At this first appearance he conveyed the impression he had lost the right lower leg and foot. My conclusion was that he had been wounded by a shot during the 1954–55 fall and winter season or in the early portion of the 1955 spring turkey hunting season. During this spring season I saw the crippled bird only twice. In 1956 I saw him four times during the spring gobbling season, and observed that the right leg was present because he put some weight on it. The following spring, April 15, 1957, I saw this turkey only once, on the last day of the season.

The maximum distance I observed this tom at any time from the original identification point was 1,200 yards; this was determined by measurement on an aerial photo map. The circular area thus encompassed is 234 acres.

Measurements of the crippled bird were: weight, exactly 18 pounds; total length, 114.5 cm.; right wing, 51.5 cm.; left wing, 50 cm.; extent, 145 cm.; tarsus, 16.5 cm.; left spur, 3.32 cm.; right spur, 3.08 cm.; beard, 30.5 cm. (12+ in.).

The supposition is that this bird was at least four years old and possibly older. At first sight in spring, 1955, since the beard then was pendulous, I considered the tom to have been two years of age.

LITERATURE CITED

MOSBY, HENRY S., AND CHARLES O. HANDLEY. 1943. The wild turkey in Virginia. Virginia Comm. of Game and Inland Fisheries, Richmond. 281pp.

Received for publication March 19, 1959.

FIG. 1. The disfigured right tibiotarsus and the normal bone of the left leg.

A COUNTING DEVICE FOR RECORDING SMALL MAMMAL ACTIVITIES

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In the course of laboratory and field experiments on orientation in small mammals, an automatic counting device has been developed. This counter is simply and inexpensively constructed (costing approximately $4.00) and would appear to be adaptable to a variety of uses in behavioral and ecological studies of mammals and other animals.

The unit consists of a 6-volt automobile solenoid and a mechanical hand tally counter. The counter's internal spring is removed to permit easy movement of the plunger shaft, and a 1½-inch flathead bolt is soldered or welded to the base of the counter so that it can be mounted on a board. The solenoid is adapted for use by removing the headpiece to allow a greater stroke, which is necessary to operate the counter properly. A 4- to 5-inch length of rigid wire is then soldered between the solenoid bar and the plunger head of the counter and the assembly is mounted on a wooden base. Exterior plywood of 1-inch thickness is suitable for this purpose (Fig. 1). In mounting the unit, care must be taken that the plunger of the counter is fully extended and the solenoid bar is placed so that its outward movement will not exceed its maximum operational stroke. It is also important that the plunger, solenoid bar and connecting wire should be parallel to the plywood mounting. The length of the solenoid stroke should be adjusted to operate the counter properly by loosening the woodscrews that hold the solenoid to the base, moving the solenoid the necessary distance toward or away from the counter, and then re-tightening the screws securely. The counting device is operated by a 6-volt d.c. power supply.

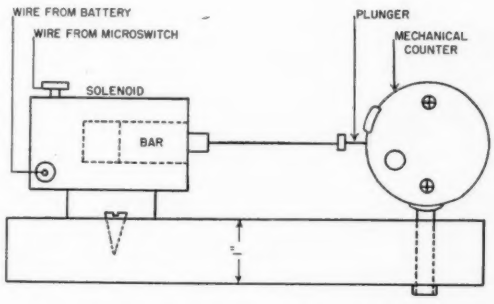

FIG. 1. Side view of mounted counting device.

In the present studies an enclosure (made of ¼-inch hardware cloth) with eight directional channels is being used in orientation experiments (Fig. 2). Each channel is equipped with a treadle, operating a microswitch, which in turn is placed in circuit with one of the counting units described above. The number of times an animal uses a particular channel in a given interval is determined by recording the number on the counter dial and dividing by two, since the animal activates the counter both when entering and leaving the channel. The eight counters are mounted on a single

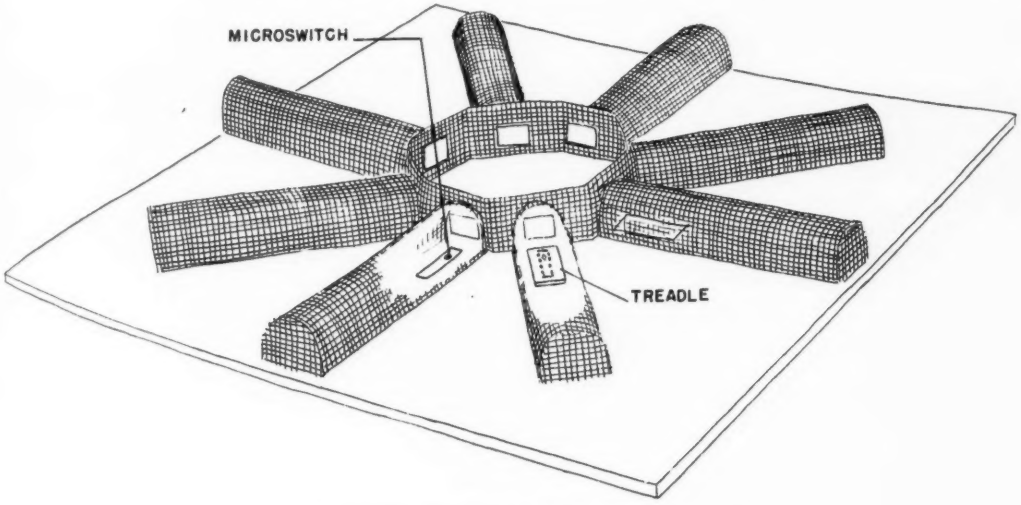

FIG. 2. Diagram of directional enclosure showing position of treadle and microswitch.

board and placed in a soundproof box. They may be separated from the enclosure with almost any desired length of wire (10–50 feet) provided the d.c. power supply yields sufficient amperage. Separation of the devices and the enclosure in this way permits an observer to record animal movements without unnecessary disturbance of the animal. A 6-amp. d.c. Mallory tapering 6-volt charger (Model 6SAC6) is used to operate the series of counters in the laboratory and a 6-volt automobile battery supplies the power in the field. The treadle-activated microswitch has an operational force of 2.5 grams which is much less than the weight of most small mammals. The weight sensitivity depends on the operational force of the type of microswitch employed as well as the balance of the treadle, and in other studies could be adjusted to limit recording of animals of certain weight range.

The author wishes to express his sincere gratitude to Dr. James N. Layne, Department of Biology, University of Florida, for his assistance and to Miss Esther Coogle, department artist, for preparing the figures.

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BOOK REVIEWS

Animal Tracks and Hunter Sign. By Ernest Thompson Seton. Doubleday & Co., New York. 1958. 160pp. $3.75.

This posthumously published book deals with animal tracks and field sign. There are 23 chapters, most of which are very short, an unnumbered epilogue entitled "A Final Word," plus a two-page index. The book is standard size. The paper, dust jacket, covers and editorial arrangement are of high quality. The price is reasonable on a physical basis alone. Editorially, the text is stretched. In the 160 pages there is enough unused space to allow for an additional 30 pages of text. The "Note to the Reader" (pp. 7 and 8) penned by Seton about 10 weeks before he died in 1946 points to a 12-year lapse in publication. In the interim, at least two books on tracks and tracking have been published, both superior to the present volume. The contribution therefore is minor.

In this phase of natural history, Seton in his lifetime was without peer. Technically, the information is accurate. Seton was a careful field recorder who measured and drew to scale the physical features of the events he wished to preserve. The plates have in the main been borrowed from the author's previous published works, particularly "Lives of Game Animals" and "Life Histories of Northern Animals." Tracks of about 50 species from toads to moose, including many domestic animals, are portrayed by sketches or ink-pad prints. Many of the chapters are interesting vignettes appropriately illustrated with tracking pictures and sketches of animal foot prints. The chapters are arranged in no discernible pattern.

I was particularly happy to see an experienced tracker say, of dog and wolf tracks, (p. 58) that he had "not found a single reliable feature that distinguished them."

Seton in his "Lives of Game Animals" states that the cottontail does not dig burrows. He implies here, however, that it does so occasionally by the phrase "not usually making burrows . . . ." Track casting is downgraded to a point where it is stated that snow tracks "cannot be cast at all" (p.34). This statement is in error, as snow tracks can be cast very well. In general, errors are few, but redundancy mars the text. Reading this book is like stirring the ashes of a camp fire—occasionally a bright coal comes to the surface, flashes brilliantly for a moment, and dies. The flashes of Seton, the mature naturalist, are scattered among what is largely the ashes of his past writings.

Of Seton's 40-odd books, I have 38 in my library (the others, if 40-odd exist, are not known to me), and none is so lacking in vitality as this one. Many, like me, will buy this book because it was written by Seton. If it was published either to make money or to add to the author's prestige, I believe it has failed on both scores.

It is disappointing to find the title page of a book on tracks by this author without the wolf-paw sketch with which he adorned autographed copies of his books.

Seton has lost none of the high regard I have for his brand of natural history, but I cannot recommend this book as the latest or best word on animal tracks and hunter sign.—ROBERT A. MCCABE, Department of Forestry and Wildlife Management, University of Wisconsin, Madison 6, Wisconsin.

Zoogeography of the Land and Island Waters. By L. F. deBeaufort. Sidgwick and Jackson, Limited. 1951. viii+208pp., 10 figs. $5.00 (U.S. agent—Macmillan Company, N.Y.).

Although completed as long ago as 1949, this textbook on historic zoogeography still has much to offer. It provides a rather detailed account of accumulated knowledge, particularly relating to mammals, birds, fresh-water fishes, and molluscs. Some information is also given about representatives of other classes. The main emphasis of the

text is on endemism. Much of the book is concerned with the role of factors of physical and historical geology that may account for endemism. Apart from a general discussion of the various zoogeographical regions and their faunas, special chapters are dedicated to a discussion of the British Isles and the Indonesian Archipelago because of the particular problems they present.

The introductory chapter is too short, and no reference is made here about how other biological sciences may aid in our understanding of zoogeography. More subheadings and maps throughout the book would have improved readability greatly.

Of particular interest are discussions of glacial relicts, and of the adaptation of African forest dwellers to a steppe environment when tropical forests were converted to steppe as a result of desiccation.

Much emphasis is given to the former existence of land bridges. According to deBeaufort, it is doubtful whether a land bridge existed between North America and Europe via Greenland and Iceland. He agrees with von Koenigswald that a land bridge did exist from China via Formosa to the Philippines. He also postulates the possibility of a land bridge between the Antarctic and New Zealand in Mesozoic times.

Evidence is presented that the Didelphiidae have a northern rather than a southern origin. The opossum may be a relict in North America, rather than a late invader from the south. No mention is made of the presence of the Hawaiian goose or nene, which is no doubt of North American origin.

A comparison between de Beaufort's book on zoogeography and *Zoogeography*, edited by Carl L. Hubbs and reviewed below, indicates that considerable progress has been made recently in the field of zoogeography. Undoubtedly, however, there is a need for a continued interest in historic zoogeography, as long as fossils are unearthed in those parts of the world where gaps in our knowledge now exist.—A. DE VOS, Ontario Agricultural College, Guelph, Ontario.

Zoogeography. Edited by Carl L. Hubbs. Publication No. 51 of the American Association for the Advancement of Science, 1515 Massachusetts Ave., Washington 5, D.C. 1958. 509pp., illus. $12.00. ($10.50 to members.)

This publication, based on two symposia, consists of 17 contributions. The contributions vary greatly not only in respect to the groups of organisms, the areas covered, and the topics stressed, but also in the length and completeness of review. This is what may be expected when so many different individual papers are put together in one volume.

Although the heterogeneity of contributions introduces a weakness, the volume is strong in the variety of viewpoints expressed and in the high degree of competence of each participant in some aspect of zoogegraphy.

There is a noticeable shift from the classical descriptive biogeography to a kinetic approach more concerned with processes and explanations than with classification of the earth into biogeographical regions. The trend toward interdisciplinary research is exemplified in several contributions.

One new approach referred to is the quantitative reconstruction of past vertebrate biocoenoses through the study of all identifiable material obtained by soil washing.

Of particular interest to the wildlife biologist are the chapters on the climate from the late Cretaceous to the present; the role of physiology in the distribution of terrestrial vertebrates; the history and affinities of the recent land mammals of western North America; Pleistocene ecology and biogeography of North America; the paleoarctic element in the New World avifauna; and the distributional patterns of vertebrates in the southern United States in relation to past and present environments.

The paper by Paul S. Martin on Pleistocene ecology and biogeography of North America is of particular interest. The author presents evidence of the influence of man on extinction of vertebrates in late Pleistocene times. He also points out a serious violation of the general rule that the smaller the surface area the greater the vulnerability to extinction; this is exemplified in the survival of a rodent on the tiny Plana Keys and another rodent on the Swan Islands.

In his paper on distributional patterns of vertebrates, Blair presents evidence from various sources indicating that the southern grasslands have not acted as a continuous barrier to the exchange of forest biotas between the eastern United States and the Mexican highlands since their origins in the late Miocene and early Pliocene.

Regardless of the weaknesses mentioned, this volume presents a significant contribution to progress in the field of zoogeography.—A. DE VOS, Ontario Agricultural College, Guelph, Ontario.

Mourning Dove Investigations 1948–1956. SE Assn. Game and Fish Comms., Atlanta, Ga., George C. Moore, Pres. Tech. Bull. No. 1, printed at Columbia, S.C., Nov. 1957. 166pp.

All wildlife administrators, game managers, and game researchers would do well to take time to read this bulletin. It is a splendid example of what properly directed research can contribute to the field of wildlife management. Much of its strength lies in its being a report on cooperative investigations between ten southeastern states (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee), The Wildlife Management Institute, and the United States Fish and Wildlife Service. Through well-directed coordination by the Fish and Wildlife Service, this team pulled together to produce the results reported in this fine bulletin. Also, through this cooperation and planning, coupled with an excellent editorial job, many of the pitfalls

of most multiauthored publications were avoided. Here the Southeast Association presents the results of eight years of study in a clear and concise manner with 83 pages of text and 83 pages of documenting tables and figures.

The objectives of the studies reported herein were based on an understanding of management needs and were directed thereto. The danger of being led astray on interesting, but less pertinent, tangents was avoided by keeping management objectives firmly in mind. The need for information on four major phases of management was recognized and practically all effort was directed toward them. These are discussed under the headings "Census and Population," "Production," "Mortality," and "Migration and Movements." Each section contains a presentation of data followed by a summary and recommendations for future studies. The recommendations also include suggestions for improvements of existing techniques and are mostly sound, practical, and based on findings, or lack of findings. The Southeastern Association is to be commended for critically analyzing its own studies and for recognizing the need for future and continuous research as being in the interests of better management.

Although most recommendations for further work seem sound, in light of data presented in this report, the suggestion that random road counts be continued as a management tool (pp. 25, 37, and 77) is bound to be questioned as to its economic practicality by many administrators and game managers. Since it is reported that 15,000 miles per month of such counts are required for statistical reliability in North Carolina during the early breeding season, when population flocking is at a minimum (p. 21), it is very doubtful that this technique can provide "useful information at low cost" (p. 36). This would be true in most of the states larger than North Carolina and especially in the western states where population clumping is apparently more prevalent than in the eastern states (p. 17), and consequently, counts would require even larger samples. In reality, it is rather risky stating that 15,000 miles "may be considered adequate for a state the size of North Carolina" (p. 21) when sample size would be more dependent on ecological heterogeneity, and consequent population distribution, rather than on the area of a given state. Although the random road count for mourning doves does not appear to be a practical management tool, it does appear, however, to be a valid research technique and should not, therefore, be discarded completely.

There are a few other very minor weaknesses in this bulletin. Occasionally a reader gets lost as a result of the same data being discussed under two or more sections. This is mostly a matter of style and on close reading one can usually find his way through. The report is extremely well documented but a few of the tables and figures could be more adequately explained. For example, in Table 60 (pp. 129–134) the symbols "N", "S", and "S and W" are used. There is no explanation of these symbols in the table, although by reading the text one can discern that they refer to cardinal directions. In like manner, by referring to the text, the reader can determine that the call counts referred to in Fig. 5 (p. 140) are from the eastern United States. Concerning call counts, both in the text and in tables and figures, it is at times uncertain whether references are made to total calls per route or average calls per stop. It is assumed that "Region 4 States," as designated in Fig. 9, refers to Region 4 of the Fish and Wildlife Service. This is the only place in this bulletin where such Region is mentioned. There are a very few typographical errors.

A few of the more interesting findings in this report follow (selected from a summary listing 39 conclusions):

1. Call counts were found to be the most valuable index to breeding populations.
2. Age ratios collected at trapping stations during hunting months were well correlated with age ratios in hunter's bags.
3. Analysis of available band recoveries shows some evidence of three major dove flyways in the United States.
4. The total band recovery of 145,000 banded doves since 1920 is only 3.7 per cent.
5. Hunter-caused mortality ranges somewhere between a minimum of 4.1 per cent (including crippling losses) and a maximum of 59 per cent, both well below the indicated first year mortality of approximately 70 per cent. Annual mortality thereafter is approximately 55 per cent.
6. There were an estimated 19,000,000 doves killed in the United States during 1955 (this is undoubtedly the greatest harvest of any one species of game bird in the United States).

Following the four major sections on different phases of the cooperative dove studies is a discussion entitled "Regulations Recommendations." In this section it is apparent that the ultimate objective of management for the benefit of the dove population and the sporting public has been uppermost in mind. Here there is a brief but excellent discussion of liberalizations versus enforcement restrictions which would be well worth reading by all interested in wildlife recreation. A number of common fallacies concerning certain restrictions are exploded and specific season and bag limit liberalizations are recommended on the basis of data resulting from the cooperative investigations.

Although published by the Southeastern Association of Game and Fish Commissioners this is certainly not merely a regional publication. Whenever possible, data from other parts of the United States have been included and compared to results of these studies. There is an excellent coverage of pertinent mourning dove literature from all over the United States.

This bulletin is undoubtedly one of the outstanding wildlife publications recently released. Coupled with many significant contributions to dove man-

agement is the demonstration that cooperative research between agencies, with proper coordination and when directed to a given end, does produce tangible and valuable results. Such studies certainly need not be limited to migratory species.

(Subsequent to the publication of this bulletin, further call-count studies, supplementary to those discussed herein, have been reported in the following paper: *Design Tests for Mourning Dove Call-count Sampling in Seven Southeastern States*, by Foote, Peters, and Finkner. J. Wildl. Mgmt., 22 (4):402–408, 1958).—FRED C. ZWICKEL, State of Washington Department of Game, Wenatchee, Washington.

Algae. The Grass of Many Waters. Second Edition. By Lewis Hanford Tiffany. Charles C. Thomas Publisher, Springfield, Illinois. 1959. 199pp. 41 plates, 13 figures. $6.50.

This second edition of a book which has been out of print for several years will be very welcome to many plant scientists, ecologists and naturalists, both professional and amateur. Those familiar with the first edition appearing 20 years ago will be pleased to learn that all the desirable features of the original have been retained while a number of interesting additions have been made.

Basically this treatment explains algae in language so nontechnical that a high school student should easily comprehend it. Yet the author has managed to compile a great deal of important information very interesting to professional ecologists as well as to the lay reader. In the early chapters, Tiffany tells what algae are, the organic foodstuffs they make, and how they reproduce. Then he proceeds in successive chapters to algae of ponds, rivers, oceans, soil and snow, to the "bizarre abodes" such as the blue-green algae of human intestinal tracts and to the red and green algae growing as epiphytes on hair of the sloth. Other chapters are devoted to fossil algal records, algae and human welfare, algal research, collection methods, and how to study algae. The text is well written and the illustrations are profuse with many different species being clearly shown on each plate.

Primarily this book is an entertaining exposé of the world of algae in which we may see not only the green pastures of aquatic life but also, from a fish's eye view, the multicolored grazing vistas made up of the red, brown, blue, and yellow algal species. The book is not a taxonomic treatment and there are no descriptions or keys to genera or species.

In telling about the algae, the author has achieved a Ripley believe-it-or-not style and array of facts; this is very effective in holding the reader's interest. At the same time the book as a whole gives an excellent idea of where and how algae fit into the scheme of life and the roles they play in the balance of nature. For example, plankton algae as an ultimate food source stand at the base of a pyramid leading thru a series of animals to man; algae to gizzard shad to game fish to man's gizzard is compared to the famous baseball combine: Tinker to Evers to Chance.

Most of the new material of the second edition has been added as a new chapter entitled "Algae and Research." Here is a description of recent occurrences off the coast of Florida of the "red tide" organism (*Gymnodinium brevis*), swarms of which have destroyed most marine life within their immediate area. Also here is summarized recent experimental work on the possible large scale cultivation of algae for food.—N. HIGINBOTHAM, Department of Botany, Washington State University, Pullman, Washington.

The Faunal Connections between Europe and North America. By Carl H. Linroth. John Wiley & Sons, Inc., New York, and Almquist & Wicksell, Stockholm. 1957. 346pp. $15.00.

Professor Lindroth's book is another proof that in our biologic world of specialization and specialists there is room for synthetic approaches. In a paradoxical way, however, a good synthesis requires a grasp of such particularly specialized disciplines as, in Lindroth's case, faunistics and taxonomy, phylogenetics and paleontology, field and experimental ecology and many others. The successful blending of these disciplines requires the training and skill of a zoogeographer. Because of the scarcity of synthetically minded researchers, the unsolved problems of zoogeography dominate the satisfactorily explained facts of animal distribution. Any attack on the problems is therefore welcomed, although the solution offered may not be the final one.

The form, typographical presentation of text, maps, tables, and diagrams are of a high, Scandinavian standard. Especially worthy of mention and praise is the fact that every species discussed is depicted by a sketch or photograph. This is a great and commendable help for the nonspecialist reader.

It is nearly impossible to account for all the new facts, the launching of ideas, and the ruling out of untenable assumptions that are compressed into the pages of this book. Especially the third and main chapter is saturated with thought-provoking arguments, tabulations, and maps. The first two parts of the treatise could be considered as independent surveys. This is not a conventional way of editing a monograph. It can, however, be defended as a highly logical sequence for presentation of the material that bears out the title of the book.

The first chapter is a check-list of selected groups of land and fresh-water animal species found on both the European and North American continents. For these groups Lindroth attempts to give a complete listing. As these species constitute those to be discussed at length in the latter chapters, their inclusion in the book is well justified.

All together 908 species compose this check-list. Among them the scarcity of mammals (20 species) is conspicuous. Lindroth explains this by the fact that no thorough comparison has been made as yet between the Palearctic and Nearctic mammals; further, that mammalian taxonomy in North America uses species criteria different from those used in the other animal groups considered. I would also add another, partial explanation of the relative scarcity of mammal species common to the two continents. The ecologic group of fresh-water dwellers is very poorly represented among mammals; the marine pinnipeds are omitted by Lindroth. In contrast, over half the bird list (106 species altogether) is taken up by marine and fresh-water forms. Another dozen or so species, also marine birds, are purposely left out because they are confined to arctic islands only, on one or both sides of the Atlantic. The two most recent crossers, apparently, escaped the attention of entomologist Lindroth (*Anthus cervinus, Bubulcus ibis*). The bulk of the list is, of course, formed of insects and other invertebrates.

The majority of these invertebrate species is claimed to be unintentionally introduced to America by human traffic across the Atlantic. This claim is based upon a carefully planned and detailed study by Lindroth of the ecology, taxonomy and distributional history of amphiatlantic insects, especially beetles on Newfoundland. This study, the monograph of human transport of animals across the North Atlantic, forms the second chapter of the book. Inclusion of primary field data, and their step-by-step evaluation, greatly increases the value of the volume. It enables the reader (especially when not acquainted with European zoogeographical literature) to familiarize himself with the working method of a zoogeographer. We follow his logic which finally solves for almost half the fauna considered the question implied in the title.

Lindroth uses historic, geographic, ecologic, biologic (we would say life history) and taxonomic criteria to pinpoint the introduced elements of the fauna. Most of the adventitious insects arrived in North America in the ballast of fishing fleets sailing from southern England. This is verified by an analysis of ecologic tolerance of the insect fauna at the points of origin, of the species suspected as having been carried in ballast, and an ecologic summary of their habitat in the area of dispersal. These arguments remind a vertebrate ecologist of the climograph concept as used in tolerance evaluation; they are certainly very inspiring and commendable reading for anyone contemplating intentional transplantation of foreign faunal elements.

The third chapter analyzes the relationships of the remainder, i.e., indigenous elements that the two continents share. The presence of amphiatlantic birds, butterflies, and spiders is explainable by their active flight or aerial drifting. There are, then, particular and exceptional cases when transoceanic dispersal means a ride on birds' legs and plumage, endurance of floating with the current, etc. Over fifty species have thus been able to cross the ocean. Most of the indigenous elements, however, are either circumpolar in distribution or if not, paleontologic evidence suggests that they were in the past. For these the Bering Strait area, as already well accepted by vertebrate paleontologists, is the area of faunal communication. After a logical and sound discussion (without new factual evidence) Lindroth shares the opinion of Hultén (1937), of Stegmann (1938), and of others that the most probable evolutionary center of holarctic faunas is northeastern Asia.

Ground arthropods without the power of flight on the North Atlantic islands offer special problems which were favorites of Lindroth's many earlier studies and expeditions. The terrestrial fauna on Greenland and the detailed analysis of beetles in surrounding areas convinced Lindroth (as first reported by him in 1931) and even the present reviewer that the facts of their distribution postulate a land connection of Greenland with Iceland and of the latter with the European continent via Scotland. Lindroth now assumes that such a bridge dates earlier than the Wisconsin glaciation. It remains to be seen how such an assumption would accord with distributional evidence of terrestrial animal groups other than those here analyzed. The existence of a sharp distributional break along Baffin Bay, as exhibited by recent Coleoptera, and the heavy Wisconsin glaciation that followed the disappearance of the bridge (and annihilated most animal life save terricolous relicts) are Lindroth's chief evidences.

The third chapter thus offers explanations, some complete and some plausible, for every species group from the list of chapter one. It does not give, however, a generally valid solution of the North Atlantic affinities of holarctic faunas. Such affinities or faunal relationships do not stop at the species level. They are observable—perhaps in a decreasing degree—through genera, subfamilies and families in the systematic treatment. They show significant difference in ecologically related and coexistent groups of biota in similar environments of the continents and, furthermore, even in the taxonomic consistence of subsequent fauna-historical periods of the past.

These aspects of the transatlantic faunal connections have hardly been touched upon and are urgently awaiting clarification with the aid of the solid basis that Lindroth's excellent treatment of the present distribution has established.—MIKLOS D. F. UDVARDY, University of British Columbia, Vancouver, Canada.

OBITUARY

Williams Adams Dayton

1885–1958

William A. Dayton was a charter member of The Wildlife Society. A lifelong student of natural science, he made major contributions in botany, ecology, and range investigations over a period of about a half century, nearly all of which was with the Forest Service.

Arthur W. Sampson and Dayton did pioneer work together in the western range country on range forage plant investigations in 1910. In 1911, Dayton was assigned to Range Management Research work in the Washington office of the Forest Service, where he later became Chief of the Division of Dendrology and Range Forage Investigations. He planned and developed the Forest Service herbarium, which, under his direction, has grown to 120,000 specimens. Because of his broad interests, the herbarium is more than a systematic collection of plants; it is also a library of information on the ecology, distribution, and economic value of plants.

Dayton was the author or co-author of over 150 articles and publications. Among these are such substantial contributions as *Important Western Browse Plants* in 1931, *The Range Plant Handbook* in 1937, and *Standardized Plant Names* in 1942. The latter includes 90,000 entries and required an unusually broad knowledge of taxonomy and lexicography. He was appointed in 1940 as the U.S. Department of Agriculture representative to collaborate with Harlan P. Kelsey in this scholarly task. Soon to be published is *Western Range Forbs,* which Dayton had completed before his death.

Active in scientific matters, Dayton was a member and often an officer in 20 scientific societies, 3 of which were international. He served as a delegate to or session chairman of several international conferences, such as the Botanical Congress. While on a forest survey party in Costa Rica he participated in the first scientific examination of the forest of Copey Oak, which is one of the largest oak trees in the world. Honors received included the Department of Agriculture Distinguished Service Award and the gold medal of the Massachusetts Horticultural Society. He was a member of the Cosmos Club and enjoyed an occasional evening there to meet with fellow scientists or to read in its library.

It was a privilege and a real pleasure to know Bill Dayton. For nearly a generation, I benefited from his amazing knowledge of the world's literature and his remarkable ability to give the precise answer to botanical questions. Of all the men I have known intimately, he was the most scholarly. But more than that, he possessed the characteristics that mold lasting respect. He was kindly, courteous, patient, and of unquestioned integrity. He was a great and good friend.—Lloyd W. Swift.

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